PB-217 050

REPORT OF THE BOARD OF TECHNICAL ADVISERS TO THE INTERNATIONAL JOINT COMMISSION ON THE POLLUTION OF INTERNATIONAL BOUNDARY WATERS, 1946-1948 INVESTIGATION; LAKE, HURON-LAKE ERIE SECTION AND LAKE SUPERIOR-LAKE HURON SECTION

International Joint Commission-
United States and Canada

August 1949

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REPORT

OF THE

BOARD OF TECHNICAL ADVISERS

TO THE

INTERNATIONAL JOINT COMMISSION

ON THE

POLLUTION OF INTERNATIONAL BOUNDARY WATERS

1946 - 1948 INVESTIGATION

LAKE HURON - LAKE ERIE SECTION

&

LAKE SUPERIOR - LAKE HURON SECTION

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REPORT
OF THE
BOARD OF TECHNICAL ADVISERS
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1946 - 1948 INVESTIGATION

LAKE HURON - LAKE ERIE SECTION
&
LAKE SUPERIOR - LAKE HURON SECTION

AUGUST - 1949

COLOR ILLUSTRATIONS REPRODUCED
IN BLACK AND WHITE

(United States) (Canada)

DETROIT RIVER

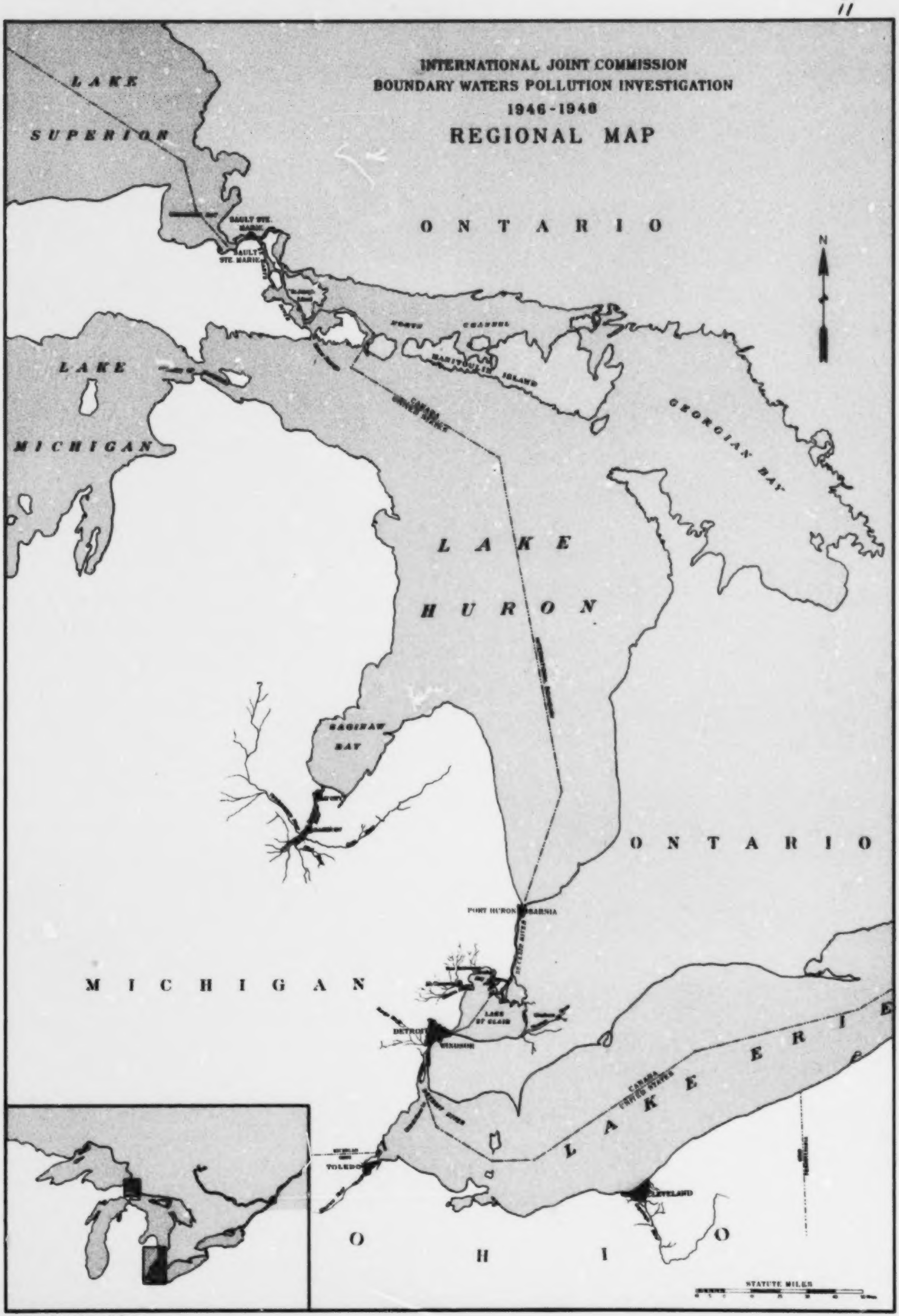
Large populations and great industries have developed along the shores of these boundary waters.

ib

"God speed that surely dawning day, that
coming hour divine

When all the nations of the earth shall boast
such borderline"

- Guy Willis Bilsland



INTERNATIONAL JOINT COMMISSION
BOUNDARY WATERS POLLUTION INVESTIGATION
1946-1948
REGIONAL MAP

LAKE SUPERIOR
SAULT STE. MARIE
SAULT STE. MARIE
ONTARIO
N
NORTH CHANNEL
MANITOULIN ISLAND
LAKE MICHIGAN
CANADA
UNITED STATES
GEORGIAN BAY
LAKE HURON
SAGINAW BAY
ONTARIO
PORT HURON
SARNIA
ST. CLAIR RIVER
MICHIGAN
LAKE ST. CLAIR
DETROIT
WINDSOR
DETROIT RIVER
TOLEDO
CANADA
UNITED STATES
LAKE ERIE
CLEVELAND
OHIO
STATUTE MILES

Litho U S Lake Survey 1949

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John M. Hepler

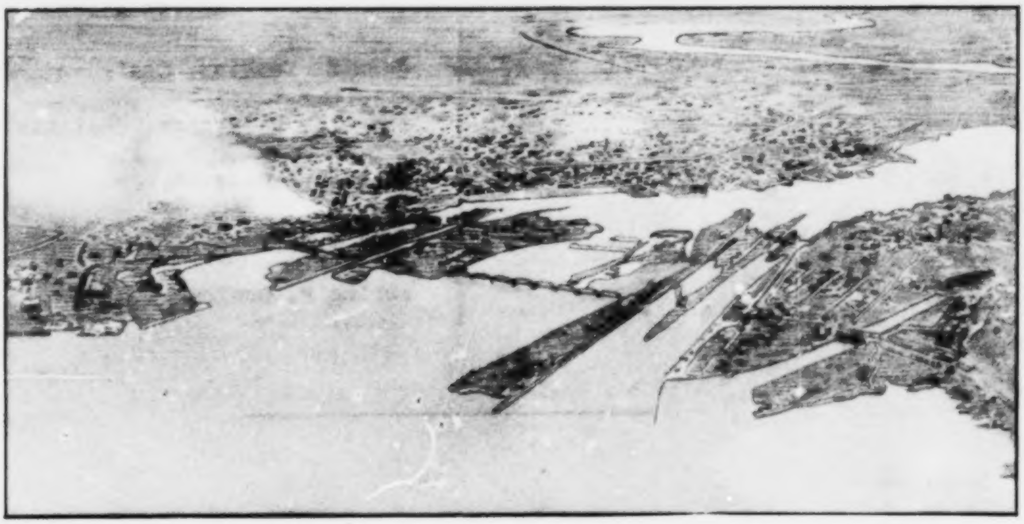
Loring F. Oeming

* Deceased

(United States) (Canada)

UPPER ST. CLAIR RIVER

These boundary waters are vitally important to the health, recreation, and national economy of both countries.



(Canada) (United States)

ST. MARYS RIVER

The welfare of the people of both countries is influenced in no small measure by the maintenence of these waters free from objectionable pollution.

LETTER OF SUBMITTAL

To the International Joint Commission
United States and Canada

The Board of Technical Advisers submits herewith its report on pollution in that section of the International Boundary Waters covered by the references to the Commission, dated April 1, and October 2, 1946.

Respectfully submitted,

Board of Technical Advisers

United States	Canada
L. M. Fisher Chairman	K.H. Ferguson Chairman
M. LeBosquet Jr.	W.R. Edmonds
John M. Hepler	A.E. Berry
L. F. Oeming	A.V. DeLaporte

August 24, 1949

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ACKNOWLEDGMENTS

Invaluable assistance has been rendered, during this investigation, by the various municipalities and industries as well as several State, Provincial, and Federal agencies on both sides of the boundary. Special acknowledgment is made to the following:

On the United States side to:

City of Detroit
Huron-Clinton Metropolitan Authority
Michigan Stream Control Commission
Michigan Department of Health
U. S. Air Forces
U. S. Coast Guard, Ninth District
U. S. Corps of Engineers, Detroit District
U. S. Geological Survey
U. S. Lake Survey
U. S. Navy, Grosse Ile (Michigan) Air Station
U. S. Public Health Service, Environmental Health Center

and on the Canadian side to:

City of Sarnia
City of Windsor
Chamber of Commerce of Windsor
Ontario Department of Health
Department of Mines and Resources of Canada

Department of National Health and Welfare

Department of Transport of Canada

Royal Canadian Air Force

Royal Canadian Mounted Police - Marine Division, Windsor District

PERSONNEL

The personnel assigned to conduct the field work in the 1946-1948 investigation were made available by the U. S. Public Health Service, the Department of National Health and Welfare of Canada, and the Ontario Department of Health, as follows:

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Acknowledgment is made to V. G. MacKenzie, H. W. Streeter, C. T. Butterfield, C. C. Ruchhoft, and M. B. Ettinger, of the U. S. Public Health Service, for their advice and assistance during the conduct of this investigation. In addition, Messrs. Ruchhoft, Ettinger, and Duncan served on a special committee in the preparation of "Analytical Methods for Boundary Waters Quality Control."

DEFINITION OF TERMS

Av.	average.
B. coli or B. coli group	the coli-aerogenes group as used in all editions of Standard Methods of Water Analysis prior to the sixth edition. It is equivalent to the coliform group as defined in later editions of Standard Methods and as used during this investigation.
Board, Board of Sanitary Experts, or Advisory Board	Board of Technical Advisers to the International Joint Commission in the 1946-1948 investigation.
B.O.D.	Biochemical Oxygen Demand.
Boundary Waters	the waters from main shore to main shore between the United States and Canada, as defined in the Treaty of 1909.
Can.	Canada.
c.c.	cubic centimeter.
c.f.s.	cubic feet per second.
Coliform or coliform group	those organisms which will ferment lactose in the presence of brilliant green bile in the proportions contained in standard dehydrated media of that type.
Commission	the International Joint Commission.
f.p.s.	feet per second.
Imp.	Imperial.
International Boundary or boundary	the boundary between the United States and Canada.
M.G.D.	million gallons per day.
median	the value which is equaled or exceeded by exactly half the values in the given list.

Michigan Stream Control Commission	agency replaced by Michigan Water Resources Commission, May 1949.
ml.	milliliters.
M.P.N. or M.P.N. Index	the number of coliform organisms per 100 ml. when calculated from multiple tube dilution tests.
No.	number.
P.A.	Public Act.
pH	hydrogen ion concentration.
Phelps Index	the number of B. coli per 100 ml. when calculated from the results of single tube dilution tests.
p.p.b.	parts per billion, by weight.
p.p.m.	parts per million, by weight.
primary or partial treatment	screening, grit removal, and sedimentation of sewage.
Section	the Lake Huron - Lake Erie Section or the Lake Superior - Lake Huron Section of the boundary waters.
slug or spill	the release of a volume of highly concentrated polluting material over a short period of time. Slugs are generally due to a deliberate discharge while spills are due to an accidental discharge.
SM	St. Marys River
U. S.	United States.
%	percent.

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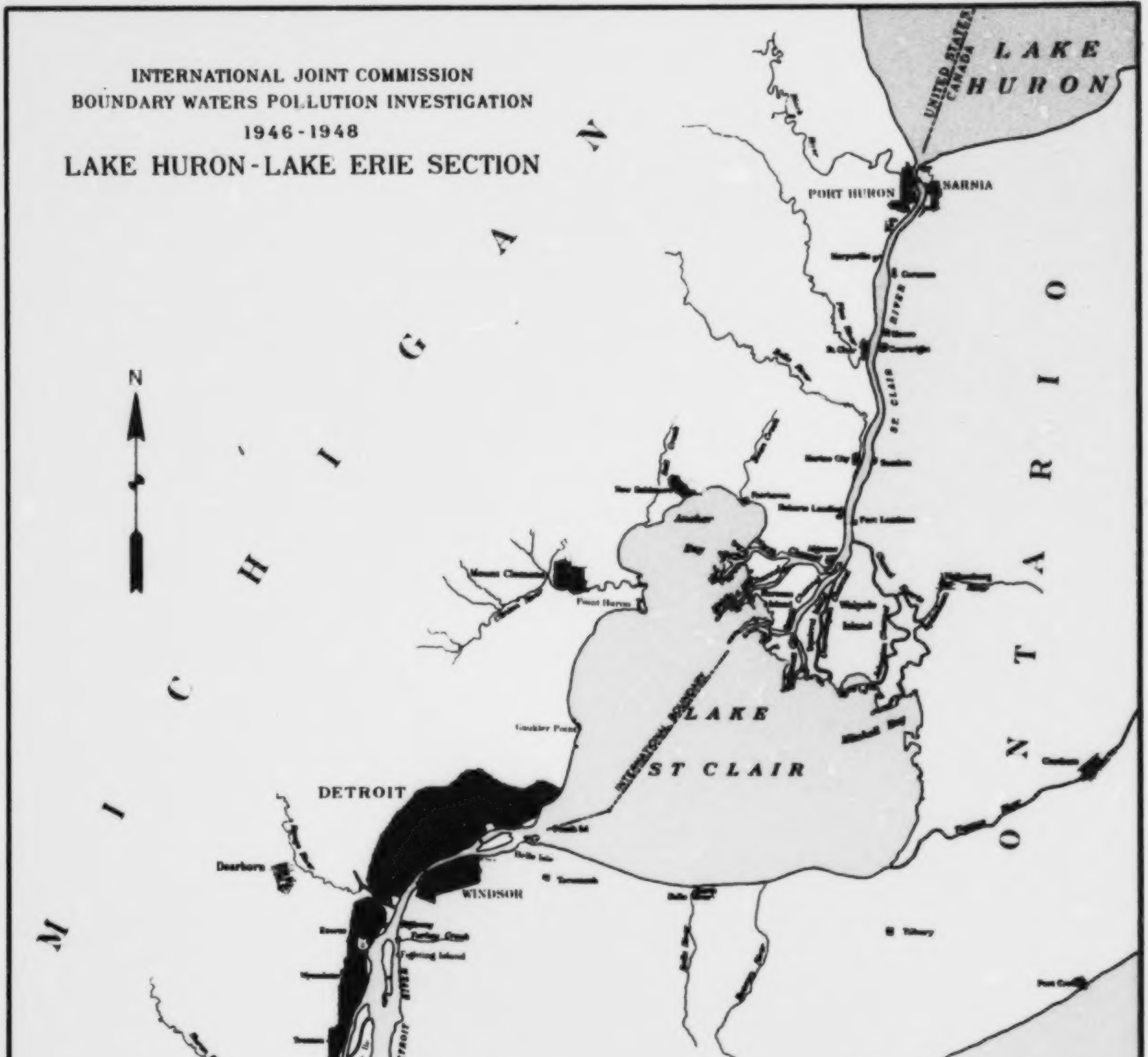
INTERNATIONAL JOINT COMMISSION
BOUNDARY WATERS POLLUTION INVESTIGATION
1946-1948
LAKE HURON-LAKE ERIE SECTION
N
M I C H I G A N
LAKE HURON
UNITED STATES
CANADA
PORT HURON
SARNIA
ST CLAIR RIVER
O N T A R I O
LAKE ST CLAIR
INTERNATIONAL BOUNDARY
Anchor Bay
Mount Clemens
Walpole Island
Point Huron
Gaukler Point
DETROIT
Dearborn
WINDSOR
DETROIT RIVER
Fighting Island
Grosse Ile
Amherstburg
Bar Point
Monroe
Maumee Bay
TOLEDO
Pigeon Bay
Point Pelee
LAKE ERIE
Pelee Island
CANADA
UNITED STATES
STATUTE MILES

Litho U.S. Lake Survey 1949

Figure 1

LAKE HURON - LAKE ERIE SECTION

1946 - 1948

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(LAKE HURON - LAKE ERIE SECTION)

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For Canada
For Michigan
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CHAPTER I

FINDINGS AND RECOMMENDATIONS

The investigation of pollution in the boundary waters of the Lake Huron - Lake Erie section has extended over the period of July, 1946, to December, 1948. In that time a comprehensive examination has been made of all phases of pollution, and relevant information has been obtained from many sources. These data have been studied and conclusions reached on the questions contained in the terms of reference to the International Joint Commission by the governments of the two countries.

This study has involved unique and complex problems. The previous investigation in 1913 was a pioneering effort in the evaluation of bacteriological pollution. In the intervening period these waters have assumed an unparalleled role in serving numerous uses on a boundary between two countries where healthful living, commerce, and recreation have attained a high level of development. These activities have focused attention on two necessities: first, the imperative need for clean waters, and secondly, the serious problem of attaining this objective. Concentration of population in urban communities, combined with tremendous advances in new industrial processes with complex waste products, has given rise to involved and complicated requirements both for the investigation and solution of this situation. The cost is high for correction, but it is higher for continuance of the defilement of these waters.

The investigation has enabled the Board of Technical Advisers to reach certain conclusions on the findings and to offer recommendations to the Commission for remedial measures. The findings of the Board are summarized herewith.

FINDINGS

1. These waters are seriously polluted in many places on both sides of the boundary. The most serious pollution exists in the St. Clair River below Port Huron and Sarnia, in Lake St. Clair along the west shore, in the Detroit River below Belle Isle, and in Lake Erie at the west end. There is progressive over-all degradation of the water between Lake Huron and Lake Erie.
2. There is a transfer of pollution from each side of the boundary to the other. This has been demonstrated by float studies, by analytical results, and by accidental discharges of specific substances.
3. There has been injury to health and property on both sides of the boundary. This has been manifested in the following ways:
   a. Health - A potential menace is present where waters polluted to the extent of these are used for domestic purposes. They are in such condition that they cannot be safely used as a potable supply without complete and continuously effective treatment. Much of the threat to health arises from such factors as bacterial overloading beyond the safe limits of water purification processes; variations in pollution with accompanying erratic chlorine demand; interference of certain types of pollution with disinfectants which destroy their germicidal properties; and the probability of certain infections being carried through a water treatment process, especially if there is any interruption or breakdown in a part of that process. This condition occurred in Detroit in 1926 when 45,000 cases of dysentery were reported among the water consumers.

      These waters are so polluted in many areas as to render them unsafe for bathing purposes. Both warning and prohibitory actions in this respect have been taken by appropriate authorities. Case histories of some typhoid fever patients in Detroit have pointed strongly to infections contracted at a Lake St. Clair beach. This damage is not only reflected in cases of typhoid fever and other reportable diseases, but it may include enteric, ear, and upper respiratory infections.

The sewage pollution present in these boundary waters must be considered as an actual and potential health hazard, whether it be through public water supplies, bathing beaches, or other vehicles. If the 1913 to 1948 trend in water pollution is permitted to continue the time will come when conditions will reach a point where it will be impossible to use these waters safely for domestic purposes.

b. Property - Injury to property has been illustrated in the cost for extending water intakes and for water treatment, both for municipalities and industries; in economic loss to owners of bathing beaches and other waterfront property; in damage to water craft; and in destruction of fish and wildlife.

c. Industry - There is evidence that these waters are polluted to such a degree as to affect their use in certain industries. An economic loss to the community, and to industry as well will occur when a plant is unable to locate inan area because of inability to secure a satisfactory water supply.

4. Substantial progress has been made in the control or elimination of pollution during the period of this investigation. Both municipalities and industries have contributed to this activity. Municipal progress has been confined largely to the planning stages, whereas industry has advanced many of its programs to the construction stage. As a result of improved control of industrial waste dis-

charges, taste difficulties in municipal water supplies were much less pronounced at the conclusion of this study than prior to 1946.

5. Public hearings held by the Commission revealed a common acceptance on the part of municipal officials and industrial management of the presence of serious pollution in these waters and the need for correction. The hearings also substantiated the findings of the Advisory Board that there was injury to health and property and interference with the various water uses on both sides of the boundary. Financing of the necessary remedial works was asserted by municipal officials to be the principal obstacle to correction.
6. The condition of these waters requires that remedial measures be undertaken as early as possible.

RECOMMENDATIONS

The Advisory Board respectfully offers the following recommendations to the Commission:

1. Remedial measures for the abatement and control of pollution in the Lake Huron - Lake Erie section of the boundary waters be undertaken at the earliest possible date. These measures should be sufficient to restore and protect the uses of these waters to which the people of both countries are rightfully entitled. Major consideration should be given to uses for domestic and industrial water supplies, recreation, fish and wildlife, sanitary purposes, and navigation.
2. Treatment of municipal wastes by sedimentation and disinfection of the effluent be undertaken by all communities as the initial step; that a program of more efficient or secondary treatment be inaugurated at as early a date as possible; and that a median coliform

M.P.N. value not exceeding 2400 per ml. as set forth in the "Objectives for Boundary Waters Quality Control" at any point in these waters, following initial dilution of waste discharges, be considered as the objective for bacterial control to attain reasonable stream sanitation. The more efficient or secondary treatment recommended will be most urgent in those zones of concentrated discharge near large centers of population or where much industrial waste is involved. It is recognized that local conditions, on either side of the boundary, may give additional emphasis to the need for this higher degree of treatment. The estimated cost for installation of intercepting sewers and primary treatment works for municipalities in this section is $51,000,000, of which $35,000,000 is for United States and $16,000,000 for Canadian communities. For the additional cost of secondary treatment of municipal wastes the estimate is $37,000,000, of which $33,000,000 is on the United States side and $4,000,000 on the Canadian side. These works must be financed through public funds.

3. Overflows from combined sewers during storm periods be treated by sedimentation and disinfection where necessary to protect the purposes for which these waters are or may be utilized.
4. Industrial wastes be treated to comply, as soon as possible, with the "Objectives for Boundary Waters Quality Control". The estimated cost for industrial waste treatment works is $16,000,000, of which $13,000,000 is for United States and $3,000,000 for Canadian industries. The problem of industrial waste disposal is the responsibility of industry.
5. Slugs and spills of objectionable wastes from industrial plants

be avoided by the installation of retention tanks or lagoons with provision for equalizing rates of discharge.

6. Sewage from vessels equipped with flush toilets and from craft used for living purposes be controlled by the installation of holding tanks, and that the tanks be emptied either by transfer of the contents to shore treatment facilities or dumped overboard in nonrestricted areas. No garbage or other refuse be discharged overboard into these waters.

7. Materials from dredging operations be dumped only at locations where they will not interfere with legitimate water uses.

8. The "Objectives for Boundary Waters Quality Control", prescribed in this report, be recognized in the development of remedial and pollution-preventive measures by municipalities and industry. These objectives should apply to both existing and new sources of wastes.

9. Consideration be given to joint community action on metropolitan or regional bases in the effective solution of mutual water and sewerage problems in this section.

10. Definite plans for financing remedial municipal works be formulated. In this, there should be co-operation between the Commission and Federal, State, Provincial, and municipal governments.

11. Continuing contact with pollution control progress be maintained through a technical committee or board, having representation from both countries.

12. The Commission take such measures as may be legally available to it to have the pollution abatement and prevention program herein outlined initiated, promoted, and effectively prosecuted.

CHAPTER II

INITIATION OF THE INVESTIGATION

THE POLLUTION PROBLEM

The waters between the United States and Canada comprise the largest body of fresh water in the world. They are vitally important to health, recreation and the national economy of both countries. Large populations and great industries have developed along the shores of these watercourses, attracted by the available facilities so essential for domestic and industrial water supplies, recreation, drainage outlets, and for transportation and power. The welfare of these developments, and indirectly, of larger areas of both countries, is influenced in no small measure by maintenance of these waters free from objectionable pollution.

Pollution control is an ever changing problem, particularly in those watercourses subject to a variety of riparian activities. At one time the major source of contamination was human sewage, and the degree of bacterial pollution was the primary concern. This continues to be an important health problem, but industrial developments in both countries have added new factors. Their wastes produce effects additional to and different from those created by the concentration of sewage bacteria. Any or all of these industrial wastes may have a deleterious effect on the aesthetic qualities of the waters as well as on their physical and chemical properties. Their health significance is secondary to sewage but they may seriously impair the use of water for domestic, recreational, industrial and other purposes. The development of new products, the expansion of industrial activity, and modifications of industrial processes all cause variations in wastes which intensify the problems of water pollution control. This is further aggravated by the demand for the widest and fullest use of these waters by populations adjacent to the boundary.

THE PREVIOUS INVESTIGATION

The pollution of boundary waters between the United States and Canada has been of concern to both countries for more than 40 years. Interest has been manifest in the extent, nature, and dispersion of pollution from each side of the boundary to the other. An answer to this situation was first sought when a comprehensive survey of these waters was undertaken in 1913 by the International Joint Commission. The "Progress Report of the International Joint Commission", dated January 16, 1914, showed clearly the extent of bacterial pollution at that time. The "Report of the Consulting Sanitary Engineer upon Remedial Measures", dated March 8, 1916, recommended procedures to be adopted for abating this pollution.

In the interval between 1913 and 1946, apart from the construction of some sewage disposal plants in the Detroit River area, much remained to be done in putting into effect the recommendations contained in the "Final Report of the International Joint Commission on the Pollution of Boundary Waters Reference", 1918. In this period many important changes took place in the area contiguous to this section of the boundary. The population increased rapidly, and a major industrial expansion occurred, particularly during the period of the second world war. These factors precipitated an interest in a further survey of pollution in the boundary waters.

AUTHORIZATION OF SURVEY

For undertaking this investigation the governments of the United States and Canada respectively requested the International Joint Commission to examine conditions in relation to treaty obligations. The first project comprised the Lake Huron-Lake Erie section, from Lake Huron above Port Huron and Sarnia to Lake Erie and the immediate waters at the entrance to Lake Erie.

The terms of reference of the two governments to the Commission, dated April 1, 1946, are as follows:

"I have the honour to inform you that the Governments of the United States and Canada have been informed that the waters of the St.Clair River, Lake St. Clair, and the Detroit River are being polluted by sewage and industrial wastes emptied into those waters. Having in mind the provisions of Article IV of the Boundary Waters Treaty signed January 11, 1909, that boundary waters and waters flowing across the boundary shall not be polluted on either side to the injury of health or property on the other side, the two Governments have agreed upon a joint Reference of the matter to the International Joint Commission, pursuant to the provisions of Article IX of said Treaty. The Commission is requested to inquire into and to report to the two Governments upon the following questions:

"(1) Are the waters referred to in the preceding paragraph, or any of them, actually being polluted on either side of the boundary to the injury of health or property on the other side of the boundary?

"(2) If the foregoing question is answered in the affirmative, to what extent, by what causes, and in what localities is such pollution taking place?

"(3) If the Commission should find that pollution of the character just referred to is taking place, what measures for remedying the situation would, in its judgment, be most practicable from the economic, sanitary and other points of view?

"(4) If the Commission should find that the construction or maintenance of remedial or preventive works is necessary to render the waters sanitary and suitable for domestic and other uses, it should indicate the nature, location and extent of such works, and the probable cost thereof, and by whom and in what proportions such cost should be borne.

"For the purpose of assisting the Commission in making the investigation and recommendations provided for in this Reference, the two Governments will, upon request, make available to the Commission the services of engineers and other specially qualified personnel of their governmental agencies, and such information and technical data as may have been acquired by such agencies, or as may be acquired by them during the course of the investigation.

"The Commission should submit its report and recommendations to the two Governments as soon as practicable."

BOARD OF TECHNICAL ADVISERS

In accordance with the terms of reference the International Joint Commission appointed a Board of Sanitary Experts, to act as technical advisers to the Commission. The action of the Commission is set forth in the minutes of its executive meeting in Montreal, Canada, on May 15, 1946 as follows:

"That the Board of Sanitary Experts in the Pollution Investigation shall consist of eight members, two from the Federal services of the United States, two from the Federal services of Canada, two from the State services of Michigan, and two from the Provincial services of Ontario.

"That the members of the Board shall be:

For the United States

J. K. Hoskins, Chief, Sanitary Engineering Division, and Assistant Surgeon General, U. S. Public Health Service, Washington, D. C. Later succeeded by L. M. Fisher, Sanitary Engineer Director, U. S. Public Health Service, Washington, D. C.

M. LeBosquet, Jr., Senior Sanitary Engineer, U. S. Public Health Service, Cincinnati, Ohio.

For Canada

G. H. Ferguson, Chief, Public Health Engineering Division, Department of National Health and Welfare, Ottawa, Ontario.

W. R. Edmonds, Senior Sanitary Engineer, Public Health Engineering Division, Department of National Health and Welfare, Ottawa, Ontario.

For Michigan

J. M. Hepler, Director, Division of Engineering, Michigan Department of Health, Lansing, Michigan.

L. F. Oeming, Sanitary Engineer, Michigan Stream Control Commission, Lansing, Michigan.

For Ontario

A. E. Berry, Director, Division of Sanitary Engineering, Ontario Department of Health, Toronto, Ontario.

A. V. DeLaporte, Chemical Engineer, in charge of Experimental Station, Ontario Department of Health, Toronto, Ontario.

"That the Joint Chairmen of the Board of Sanitary Experts shall be J. K. Hoskins (later L. M. Fisher), whose duty it will be to preside over meetings of the Board in the United States, and G. H. Ferguson, who will preside over meetings in Canada. The two Chairmen will jointly act as liaison officers between the Board and the Commission.

"That the Board shall have authority to enlist the cooperation of technical officers of other Federal, Provincial or State Departments or agencies in the United States and Canada; to employ such technical and clerical assistance, to acquire such equipment, and to make such expenditures for travel, as may be found necessary."

ORGANIZATION FOR LAKE HURON - LAKE ERIE INVESTIGATION

Field work on the survey of the Lake Huron - Lake Erie section of the boundary waters was initiated in August, 1946. The personnel for this work was supplied by the U. S. Public Health Service, the Department of National Health and Welfare of Canada, the Michigan Stream Control Commission and the Ontario Department of Health. The field work on the United States side of the boundary was under the direction of H. H. Black, later succeeded by R. C. Palange, both Sanitary Engineers of the U. S. Public Health Service, and on the Canadian side under A. V. DeLaporte.

General Procedure

The Board of Technical Advisers organized the field work, distributing it between the United States and the Canadian field staffs. Each undertook to examine a part of the section. Later the same areas were examined by the other staff. Field laboratories were established at Detroit, Sarnia, and Windsor. The laboratories of the Ontario Department of Health at Toronto, Ontario, the Michigan Stream Control Commission at Wyandotte, Michigan, the U. S. Public Health Service at Cincinnati, Ohio, were utilized for certain examinations in connection with industrial waste surveys. Field studies included sampling and analysis of the boundary waters and tributaries, float tests for determining the direction of currents, visual examinations of the waters, and investigations of industries and other sources of pollution.

Selection and Designation of Sampling Points

The selection of sampling points for this investigation was influenced by such factors as the location of known pollution sources, the characteristics of the stream flows, and the location of points used during the 1913 survey. The known pollution sources included municipal and industrial sewer outlets found along the shores of these waters and tributaries. Stream flow characteristics were considered significant in that they influence the dispersion of pollution throughout these boundary waters. Comparison of results with those of the 1913 survey was desired, and many of the sampling points used in the 1946-1948 investigation were the same.

For the purpose of identifying the location of sampling ranges, sewer outlets, and other important points on the rivers and their tributaries, a mileage index system was used for the present investigation. This system involves the use of one or more letters to identify the stream or streams, followed by a number which represents the distance in river miles from the mouth or other point of reference. The reference points correspond to the zero mileage points established by the U. S. Corps of Engineers.

The zero mileage point for the St. Clair River was taken in the South Channel, between Light No. 6 and Buoy No. 9, and for the Detroit River, at the Detroit River Light opposite Pointe Mouillee. (See figure 1). On the tributaries, the letter or letters designating the main stream are retained and another letter or letters added to designate the tributary. The mileage index figure used for the tributary represents the distance from the zero reference point of the main stream to the mouth of the tributary plus the mileage from the mouth of the tributary to the point or range concerned.

The letters used in designating the various streams, with the distances from the zero reference points to the tributary outlets, are given in table 1.

Table 1 - RIVER AND LAKE DESIGNATIONS WITH MILEAGES FROM ZERO REFERENCE POINTS

Watercourse	Designation	Mileage
St. Clair River	SR	-
Black River	SR Bk	36.5
Talford Creek	SR Ta	31.1
Baby Creek	SR Ba	26.3
Pine River	SR Pn	25.1
Belle River (U.S.)	SR Be	17.0
Lake St. Clair	-	-
Sydenham River	Sy	-
Chenal Ecarte	CE	-
Thames River	Th	-
Belle River (Canada)	Be	-
Milk River	MR	-
Clinton River	Cl	-
North Branch	Cl N	11.2
Middle Branch	Cl M	11.2
Red Run	Cl RR	17.1
Beaver Creek	Cl RR Bv	22.0
Bear Creek	Cl RR Br	22.2
Detroit River	Dt	-
Fox Creek	Dt Fx	30.8
Conner Creek	Dt Cn	29.5
Rouge River	Dt Rg	19.3
Ecorse River	Dt ER	16.2
Huron River	Dt Hn	1.6
Lake Erie	-	-
Raisin River	Ra	-

The river mileage index system was not adaptable for the lakes. For these, a grid system was established using Roman numerals and letters for the terminal points on each range. Sampling points were identified by the range designation and a number showing the distance in miles along the range from a fixed reference point. For tributaries discharging into the lakes, mileage index numbers indicate the distance from the mouth of the tributary at the lake to the point designated. Points on branches of tributaries were referred to the zero point of the main tributary.

Laboratory Determinations on River and Lake Samples

In the early stages of this investigation all recognized tests for measuring domestic and industrial pollution were made on a routine basis. Routine determinations included coliforms, chlorides, phenols, ammonia, chlorine demand, dissolved oxygen, biochemical oxygen demand, hydrogen ion concentration (pH), turbidity, and alkalinity. Tests for oils, cyanides, solids, tastes, and odors were made periodically. After it was found that certain of the routine tests would be of limited value in disclosing the nature or extent of the pollution, they were discontinued. This resulted, for example, in the elimination of the hydrogen ion concentration, alkalinity, and chloride tests at certain locations.

In general, analytical procedures followed were those contained in "Standard Methods for Water Analysis", 8th and 9th Editions. Specific techniques were developed where an accepted method was not available, where the standard test for a specific compound was not sensitive enough for the high dilutions encountered, or where other substances caused interference. Such special procedures included those for oils, phenols, cyanides, and tastes.

Possible variations in techniques between the laboratories of the two field staffs were recognized and guarded against in many ways. Specific batches of laboratory media were set aside for this investigation and all tests conducted in either laboratory were made with the same media. Sampling assignments were interchanged from time to time in order that any variations in techniques would tend to be minimized. Checks on analytical procedures were made by dividing samples between laboratories.

The numbers of samples collected and of analyses made during this investigation are presented in table 2.

Table 2 - SAMPLES COLLECTED AND ANALYSES MADE

Area or Source	Bacteriological Examinations	Chemical Examinations	
		Samples	Determinations
Lake Huron	94	272	544
St. Clair River	1,688	3,082	9,431
Lake St. Clair	1,979	2,389	14,240
Detroit River	3,806	4,295	23,894
Lake Erie	534	746	3,722
Municipalities	1,337	494	3,327
Industries	-	778	7,436
Total	9,438	12,056	62,594

CHAPTER III

GENERAL DESCRIPTION

The Lake Huron - Lake Erie section comprises the drainage basins of the St. Clair River, Lake St. Clair, and the Detroit River with their various tributary streams. The entire basin contains an area of 8,421 square miles or about 3 percent of the total drainage area of the Great Lakes System. It is divided almost equally between the United States and Canada, with 4,093 square miles in the State of Michigan and 4,328 square miles in the Province of Ontario. The locations of these lakes and streams are shown in figure 1. Physical characteristics and descriptive features are discussed herein.

THE ST. CLAIR RIVER AND TRIBUTARIES

The St. Clair River is the connecting waterway between Lake Huron and Lake St. Clair, flowing in a southerly direction from Lake Huron. This river drains a total of 1,414 square miles, of which 1,311 are in the United States and 103 in Canada. The stream is about 40 miles long. The river has two characteristic sections, the upper or normal channel, and the lower or delta-like portion. The upper channel extends from Lake Huron to Algonac, a distance of about 28 miles. Below Algonac the river divides into several branches to form the delta portion commonly known as the St. Clair Flats. The branch used for navigation is called the South Channel. The International Boundary passes through this channel. Depths in the upper portion of the river vary from 25 to 75 feet. Navigable depths in the South Channel vary from 25 to 45 feet. The mean fall of the stream from Lake Huron to Lake St. Clair is slightly over 5 feet.

The principal tributaries draining into the St. Clair River are the Black, Pine, and Belle Rivers, all of which enter on the United States side. The largest of these is the Black River, draining an area of 690 square miles. From its source in the north central part of Sanilac County it flows southeasterly across Sanilac and St. Clair Counties to its mouth at Port Huron. The main stem of the Black River is about 60 miles long and falls about 200 feet from its source to the mouth. The river has been improved by dredging a channel which extends from the mouth to the Grand Trunk Western Railroad bridge, a distance of 8,200 feet. This channel varies in width from 160 feet at the lower end to 75 feet at the upper end. A settling basin or channel, 75 feet wide, has been dredged for a distance of 2,300 feet upstream from the bridge. Surveys made in 1947 indicate controlling depths of 19 feet from the mouth to 600 feet above the railroad bridge. This entire section is subject to shoaling and requires dredging for maintenance. Above these improvements the Black River is navigable only for small craft.

An artificial canal was constructed in 1912 between Lake Huron and the Black River to provide flushing and diluting water for relieving nuisance conditions in the lower Black River. This canal is about 6,000 feet long, 50 feet wide, and 8 feet in depth. In 1930, backwater gates were installed at the Lake Huron end to prevent a reversal of flow into the lake resulting from flood or other unusual conditions in the Black River.

The Pine River empties into the St. Clair River at the Village of St. Clair, Michigan. A channel 100 feet wide and 13 feet deep has been dredged for a distance of 2,500 feet above the mouth, and thence 75 feet wide and 11 feet deep for a further distance of 3,300 feet, or a total of 5,800 feet. Although no dredging has been done since 1899, a survey made in October 1944 showed a controlling depth of 9 feet for a distance of 3,000 feet above the mouth, gradually decreasing to 3 feet at a point 10,000 feet above the mouth. The lower sections of the stream are used mainly by vessels transporting sand and gravel.

The Belle River flows into the St. Clair River near the southerly limits of Marine City, Michigan. Originally a channel, with depths varying from 14 feet at the lower end to 13 feet at the upper reaches, was dredged for a distance of 5,400 feet above the mouth. Although no dredging operations have taken place since 1899, soundings made in October 1947 showed a controlling depth of 8 feet in the lower portion, which decreased to 5 feet in the upper portion of the dredged section. This stream is used almost exclusively as a winter harbor for vessels of medium size.

LAKE ST. CLAIR AND TRIBUTARIES

The St. Clair River discharges into Lake St. Clair, which lies between Lake Huron and Lake Erie and is the smallest in the Great Lakes chain. The lake is a shallow basin, with low, marshy shores and gently sloping bottom. The maximum natural depth is about 21 feet. A dredged channel, 700 to 800 feet wide and 25 feet deep, extends from the outlet of the South Channel of the St. Clair River southwesterly across the lake to the head of the Detroit River, a distance of about 17 miles. The surface area of the lake, at mean water datum of 574.7 feet, is 430 square miles. Of the total 5,009 square miles of drainage area, 996 lie in the United States and 4,013 in Canada. There are no large commercial establishments, industrial communities, or large harbors located around the lake. In addition to the St. Clair River, the lake receives the flow from the Clinton River on the United States side and the Chenal Ecarte and the Thames, Sydenham, Ruscom, and Belle Rivers on the Canadian side.

Two dumping grounds for dredged material have been established in United States waters at the southwest corner of Lake St. Clair, one on each side of the navigation channel. The larger dumping area starts 2 miles east of Windmill Point and extends into the lake for a distance of 4 miles between the east edge of the ship channel and the International Boundary. The area is irregular in shape and has a maximum length of 9,500 feet. The smaller dumping area lies between the ship channel and the United States shore. It is rectangular in shape, about 2 miles long and 1,000 feet wide.

The Clinton River is the largest United States tributary to Lake St. Clair. It drains an area of about 760 square miles. Its origin is in Bushman Lakes in upper Oakland County. It flows southwesterly to Pontiac, northeasterly to the Oakland-Macomb County line, and then southeasterly into the west side of Anchor Bay, about 2 miles north of Point Huron. This river is about 50 miles long and falls about 425 feet between the source and the mouth. A dredged channel, 8 feet deep and 80 to 100 feet wide, extends from the mouth upstream to Mt. Clemens, a distance of about 8 miles. The most recent dredging operations took place in 1916 on the main river and in 1938 at the entrance channel in Lake St. Clair. Surveys made in October 1947 showed the controlling depth to be 5 feet for a distance of about 5 miles above the mouth. This gradually reduces to 3 feet in the next 2 miles. Vessel traffic on the stream is limited to shallow draft scows, tugs, fishing boats, and recreational craft.

The Chenal Ecarte, on the Canadian side, is a natural channel between the St. Clair River and Lake St. Clair. It branches from the main channel of the St. Clair River below Port Lambton and flows in a southeasterly and then southerly direction for a distance of about 18 miles to its mouth in Mitchell Bay. The stream is navigable for vessels having drafts up to 18 feet, and it provides access to the Sydenham River from the St. Clair River.

The Sydenham River consists of two main tributaries, the North Branch and the East Branch. The North Branch rises in Warwick Township, Lambton County, and thence flows in a southwesterly and southerly direction for about 50 miles. The East Branch originates above Strathroy, in Middlesex County, and flows in a southwesterly direction a distance of over 80 miles to its confluence with the North Branch above Wallaceburg, Ontario. The main stream then flows southwesterly about 5 miles where it joins the Chenal Ecarte at a point about 8 miles above Lake St. Clair. The Sydenham River drains an area of about 1,050 square miles. The total fall is about 192 feet. The stream is navigable for vessels of 14-foot draft for a distance of 4 miles, from the Chenal Ecarte to Wallaceburg.

The Thames River, draining an area of about 2,135 square miles, is the largest of the streams tributary to Lake St. Clair. The headwaters rise in two branches, one near Mitchell and the other near Stratford. The stream flows in a southwesterly direction for a distance of about 170 miles to its mouth at the southeast corner of Lake St. Clair. An approach channel, approximately 8,100 feet long and 100 feet wide, has been dredged across the shallows in Lake St. Clair. This dredging was completed in 1947 and provides a controlling depth of 10 feet. A channel 11 feet deep has been dredged from the mouth to the city of Chatham, about 20 miles upstream. The river is navigable for 5-foot draft to Louisville, about 7 miles above Chatham.

The Belle and Ruscom Rivers are the principal tributaries discharging into the south portion of Lake St. Clair. They originate in Gosfield North

Township and flow in a northerly direction to the lake. The mouth of the Belle River is at the village of Belle River, Ontario. The Rusoom River discharges about 5 miles east of the Belle River.

THE DETROIT RIVER AND TRIBUTARIES

The Detroit River is the outlet for Lake St. Clair. It begins at Windmill Point and flows in a westerly and then southerly direction for a distance of about 31 miles to its mouth at Lake Erie. The river drains an area of 1,998 square miles, of which 1,786 are in the United States and 212 in Canada. The upper 13 miles of the stream, above Fighting Island, has an unbroken cross section with an average width of 2,400 feet, except at its head where it is divided by Peach Island and Belle Isle. The southerly or lower portion broadens out and is characterized by many islands and shallow expanses. The two largest islands are Fighting Island and Grosse Ile. The former lies in Canadian waters opposite Ecorse and Riverview. Grosse Ile extends from Wyandotte to Gibraltar in United States waters. There are several smaller islands, with large areas of marsh land, located throughout the river. The mean fall of the river from Lake St. Clair to Lake Erie is 2.8 feet. In the upper river the bottom is earth formation, while the lower river consists of earth and boulders, with the exception of a section of bedrock and boulders beginning opposite Bois Blanc Island and extending south towards Lake Erie. The banks are steep in the upper river but are gently sloping in the lower portion.

Although there are no designated dumping grounds in the Detroit River, the area north of Fighting Island, in United States waters, is presently being used by the U. S. Corps of Engineers for disposal of material dredged from the lower Rouge River.

The Rouge River, on the United States side, drains an area of 467 square miles. It rises in Oakland County, flows southwesterly into Wayne County and then southeasterly into the Detroit River. The main stream is approximately 32 miles long and falls about 360 feet from its headwaters to the mouth. The lower 3½ miles, through the Short-Cut Canal, consists of a dredged channel for use of vessel traffic serving the industries in the area. Controlling depths approximate 20 feet for a middle channel width of 120 feet. The Short-Cut Canal is an artificial connection, 3,000 feet long, from the Detroit River to a bend in the Rouge River. This eliminates an "S" shaped curve in the lower Rouge River and shortens the distance to upstream points by about one mile.

The Huron River basin has an area of 1,043 square miles. Its source is in Big Lake in Oakland County, Michigan, and it flows southwesterly through Washtenaw County, then southeasterly through several intermediate counties to its mouth north of Pointe Mouillee. It is about 80 miles long and falls about 440 feet from headwaters to mouth. The major part of its drainage reaches the main stream above Ann Arbor, and from this point downstream it receives no important tributaries. No maintenance dredging operations are carried on in this stream.

LAKE ERIE - WEST END

In addition to the Detroit River two major streams empty into the west end of Lake Erie. The Raisin River, entering at Monroe, Michigan, drains an area of 1,125 square miles. The Maumee River drains an area of 6,720 square miles and enters the lake at Toledo, Ohio. The two cities are approached by dredged channels. The west end of Lake Erie is relatively shallow. The shore is gently sloping, and there is extensive marsh land.

A tabulation of the principal drainage areas from Lake Huron to Lake Erie is given in table 3.

Table 3 - PRINCIPAL DRAINAGE AREAS - LAKE HURON TO LAKE ERIE

Stream or Lake	Drainage Area in Square Miles		
	United States	Canada	Total
St. Clair River	1,311*	103*	1,414*
Black River	690	-	
Lake St. Clair	996*	4,013*	5,009*
Clinton River	760	-	
Sydenham River	-	1,050	
Thames River	-	2,135	
Detroit River	1,786*	212*	1,998*
Rouge River	467	-	
Huron River	1,043	-	
Totals	4,093*	4,328*	8,421*

*Includes drainage area of all tributaries

TOPOGRAPHY

The drainage area of the Lake Huron - Lake Erie section extends in a north and south direction along both sides of the International Boundary. The topography is characterized by gradually rising terrain from the main waters to the headwaters of the tributary streams. Mean water elevations, referred to mean tide at New York, are 579.8 feet for Lake Huron, 574.7 feet for Lake St. Clair, and 571.9 feet for Lake Erie. The ground elevations range up to about 800 feet in the St.Clair and Detroit River basins. The valleys of the tributary streams in Michigan are generally broad and flat up to the headwaters. Beyond the headwaters the terrain rises quite sharply to the maximum altitude. In Ontario the valleys of the tributaries are long and narrow, but the terrain also rises quite sharply from the headwaters to the maximum elevations.

GEOLOGY

The bedrock of this area consists essentially of sedimentary rocks laid down during the Devonian Period of the Paleozoic Era. These sedimentary rocks are principally limestones, shales, and sandstones, with some conglomerates. The thickness of the beds varies from 200 to 1,700 feet. A glacial and post-glacial drift mantle overlies these rock beds throughout the area. It varies in thickness up to 600 feet and is responsible for much of the smoothness of the ground surface of the region. While the surface in general is smooth or broadly rolling, it is broken here and there by low morainic accumulations and by beach ridges of former lakes.

Extensive beds of rock salt underlie the entire area on both sides of the International Boundary. In Michigan the beds are generally continuous from Trenton to Port Huron, but the salt does not form a continuous sheet or bed in Ontario. The band is narrow in width in the lower Detroit River, widening as it extends northward toward the upper St. Clair River. The beds lie over 2,000 feet below the surface in the northern portions. The depth of cover decreases to about 1,000 feet in the southern sections. The thickness of the salt beds generally varies between 100 and 300 feet but reaches almost 700 feet in the central regions. Throughout the area the beds are stratified by dolomitic sediment and shale.

CLIMATE

The climate of this section is one of considerable variation since it lies in the pathway of storms that sweep across the lake region. It is, however, modified to a certain extent by the influence of the surrounding lakes. Sub-zero temperatures occur during January and February, but the winter cold is generally less severe than in regions not affected by such large bodies of water. The lower winter temperatures occur in the elevated areas of the northern portions.

During winter months temperatures are sometimes low enough to cause the formation of a solid ice cover in most sections of these waters. Ice forming along the shores of Lake Huron is broken free by winds or other forces and enters the St. Clair River in large floes. The ice begins to jam in the narrow reach of the river below the village of St. Clair. Additional floes wedge into this jam and form a barrier which at times extends as far upstream as the Black River. The ice jams frequently persist until broken in the spring by tugs or explosives. A solid ice cover at times extends from above Roberts Landing down through the St. Clair Flats to the lower end of Lake St. Clair.

Currents in the Detroit River are generally sufficient to prevent the formation of a solid ice cover. Ice forms near the shores along the entire stream. Occasionally, ice floating down from Lake St. Clair has partially blocked the United States channel upstream from Belle Isle. A complete bridging of the mouth of this channel has been observed, with the result that subsequent ice floes were diverted to the main channel between Belle

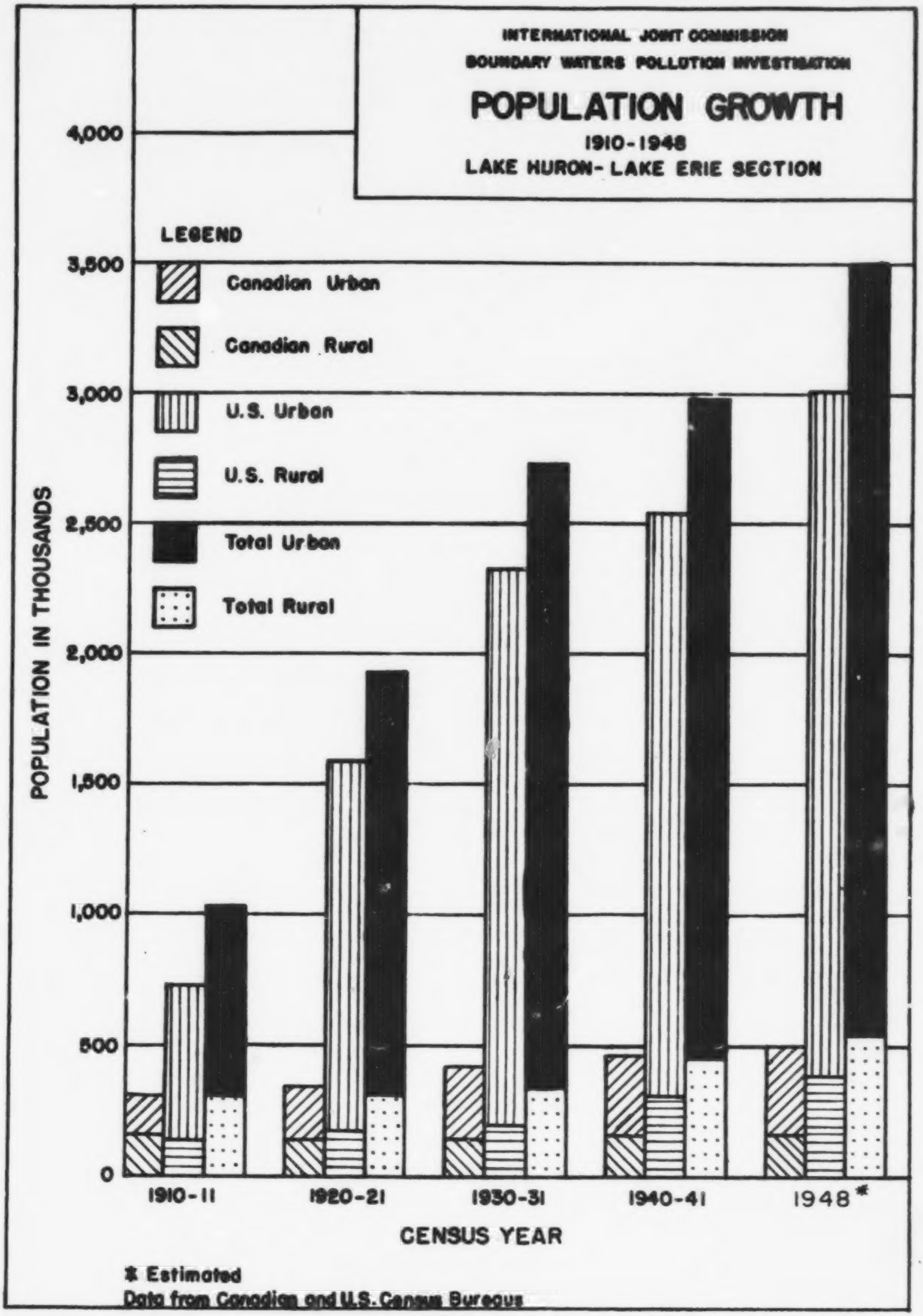
Isle and Canada. Numerous ice patches or fields occur in the lower section of the river.

Precipitation is well distributed throughout the year but is somewhat greater during the spring and summer than during other seasons. Snowfall is heaviest in the northern parts of the area, the accumulated depth sometimes reaching 2 to 3 feet. Elsewhere snowfall is less and is soon melted by warm or rainy weather. During many winters the ground is bare of snow for a part of the season. The prevailing winds are from the southwest, with an average hourly velocity of 10 to 12 miles. A maximum velocity of 67 miles per hour has been recorded.

Data on temperatures, precipitation, and winds for selected stations are given in table 4.

Table 4 - CLIMATOLOGICAL DATA FOR SELECTED STATIONS
From Period of Record to 1947, inclusive

Station	Temperature - Degrees F.				Precipitation - Inches				Wind		
	Yrs. of Record	Annual Average	Maximum	Minimum	Yrs. of Record	Average	Maximum	Minimum	Yrs. of Record	Av. Vel. M.P.H.	Prevailing Direction
Goderich, Ont.	31	45	95	-14	45	28.36	-	-	16	9.8	SW
Port Huron, Mich.	73	46.4	104	-25	72	29.35	41.96	19.82	62	-	SW
Wallaceburg, Ont.	30	47	-	-	30	27.12	-	-	-	-	-
Mt. Clemens, Mich.	48	48.0	106	-24	49	28.12	38.17	19.30	47	-	SW
London, Ont.	54	46	-	-	54	38.17	-	-	-	-	-
Detroit, Mich.	73	48.7	104	-24	77	31.47	47.69	21.06	65	11	SW
Windsor, Ont.	47	48	-	-	47	31.12	-	-	5	10.3	SW
Monroe, Mich.	31	49.9	106	-21	31	30.38	41.41	20.97	41	-	SW
Pelee Island, Ont.	36	49	-	-	36	29.50	-	-	-	-	-



* Estimated

Data from Canadian and U.S. Census Bureaus

Figure 2

(Follows Page 28)

POPULATION

The population in the area, based on the census years of 1940 and 1941, totalled approximately 2,975,000. Estimates made in 1948 indicate the population to be about 3,487,000. In 1948 the population was classified as 15 percent rural and 85 percent urban. For purposes of this investigation, municipalities having populations under 1,000 have been classified as rural and those over 1,000 as urban. Figure 2 shows the growth of population from 1910 to 1948. The major increase during this period occurred in the urban population on the United States side.

The southern part of the area is more thickly populated, containing such large cities as Detroit, Wyandotte, and Windsor. Population changes for the entire Lake Huron - Lake Erie section and for the principal municipalities from 1910 to 1948 are given in tables 5 and 6. The population density, based on the 1948 figures and expressed as persons per square mile, was about 700 for Michigan, 110 for Ontario, and 400 for the entire area.

Table 5 - DISTRIBUTION OF POPULATION BY DRAINAGE BASINS, 1940-1941 AND 1948

Drainage Basin	Michigan			Ontario			Combined		
	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban	Total
1940-1941									
St.Clair River	47,500	43,600	91,100	3,300	18,700	22,000	50,800	62,300	113,100
Lake St.Clair	121,500	190,200	311,700	134,700	161,300	296,000	256,200	351,500	607,700
Detroit River	128,700	1,997,000	2,125,700	15,400	113,100	128,500	144,100	2,110,100	2,254,100
Totals	297,700	2,230,800	2,528,500	153,400	293,100	446,500	451,100	2,523,900	2,975,000
1948									
St. Clair River	60,200	47,500	107,700	2,800	24,400	27,200	63,000	71,900	134,900
Lake St.Clair	161,100	239,600	400,700	128,300	180,900	309,200	289,400	420,500	709,900
Detroit River	160,400	2,333,800	2,494,200	17,600	130,000	147,600	178,000	2,463,800	2,641,800
Totals	381,700	2,620,900	3,002,600	148,700	335,300	484,000	530,400	2,956,200	3,486,600

Table 6 - POPULATION CHANGES IN PRINCIPAL MUNICIPALITIES

Municipality	1910-1911	1920-1921	1930-1931	1940-1941	1948 (Estimated)
Lake Huron-Lake Erie Basin	1,024,600	1,929,600	2,734,000	2,975,000	3,486,600
Port Huron, Mich.	18,863	25,944	31,361	32,759	38,900
St. Clair, Mich.	2,633	3,204	3,389	3,471	4,100
Marine City, Mich.	3,770	3,731	3,462	3,633	4.300
Mt.Clemens, Mich.	7,707	9,488	13,497	14,389	22,300
Detroit, Mich.	465,766	993,678	1,568,662	1,623,452	1,888,200
Wyandotte, Mich.	8,287	13,851	28,368	30,618	37,700
Sarnia, Ont.	9,947	14,877	18,191	18,731	23,000
Wallaceburg, Ont.	3,438	4,006	4,326	4,986	6,900
Windsor, Ont.	23,433	55,935	98,179	105,311	119,600
Amherstburg, Ont.	2,560	2,769	2,759	2,853	3,300

LAND USE AND DEVELOPMENT

The Lake Huron - Lake Erie section is devoted chiefly to agricultural, industrial, and recreational uses. The northern part, except for the Port Huron - Sarnia district, is used for farming, while that in the south is used for industrial purposes. Recreational facilities, such as summer cottages, fishing areas, and bathing beaches, are distributed throughout the region. There is little forest land. The forests are mainly small isolated woodlots, and these probably have little or no effect upon the flow or quality of the streams.

The agricultural areas consist of relatively small, individually-owned farms. In some sections as much as 90 percent of the acreage is used for this purpose. Chief products are field crops, vegetables, and fruits. There are also large yields of dairy and poultry products.

The automobile industry has been mainly responsible for the rapid industrial growth in the lower part of the section during the past 30 years. This industry has brought about the development of many related activities such as steel mills, blast furnaces, tool and die manufacturing, and coke plants. Other prominent industries include chemical plants, pulp and paper mills, distilleries, oil refineries, and rubber processing plants. In the Sarnia area rapid industrial expansion occurred during World War II. Oil refineries, synthetic rubber plants, and chemical plants were built or expanded during this period. The widespread use of contiguous areas for agricultural purposes has resulted in the establishment of many food processing plants such as canneries, dairies, and beet sugar refineries, especially in the upper and central portions of the Lake Huron - Lake Erie section.

Considerable use has been made of many of the islands, for both industrial and recreational purposes. Zug Island, Fighting Island, and the upper end of Grosse Ile are being used for the disposal of waste materials produced by the manufacture of caustic soda and soda ash. The islands of the St. Clair Flats are used for summer camps, hunting, and fishing centers. Belle Isle and Bois Blanc Island are confined to recreational purposes. Bathing has been prohibited in the waters around Bois Blanc Island for the past few years.

The largest concentrations of summer residences are situated on both shores of the St. Clair River and Lake St. Clair and on the Canadian shore of the lower Detroit River. Bathing beaches are available principally on the west shore of Lake St. Clair and on Belle Isle, in the Detroit River. Wildlife habitats are located throughout the region, the important ones being in the St. Clair Flats, Mitchell Bay, Bar Point, and Pointe Mouillee areas. Although there is little or no commercial fishing, there is a considerable amount of sport fishing, in both winter and summer. Statutes of the State of Michigan prohibit the setting of nets on the United States side of the connecting waters between Lake Huron and Lake Erie. The St. Clair River and Flats and the Lake St. Clair areas enjoy a wide reputation for bass, pickerel, muskellunge, and perch fishing.

CHAPTER IV

HYDROMETRIC DATA

Hydrometric data on a watercourse can be used to evaluate the effects of flow, currents, distribution into channels, and other related factors which influence stream pollution. In the Lake Huron-Lake Erie section large volumes of water, strong and variable currents, and numerous channels transport and dilute the incoming waste discharges. Pollutants which are highly concentrated at the point of discharge may become greatly diluted in certain areas and may remain concentrated in others. Even these dilute quantities may be carried long distances and cause objectionable conditions in the boundary waters. Pollution is important at its immediate point of discharge. The degree of its subsequent importance will be influenced by the time of flow, volume, intermingling, and other stream characteristics.

A detailed knowledge of river and lake currents is essential in determining transboundary travel of polluted waters.

SOURCES OF INFORMATION

Hydrometric data presented in this report were obtained from studies made in the field by the Commission's staffs and from available records and reports of various other governmental agencies.

Flow records for the connecting waters between Lake Huron and Lake Erie were furnished by the U. S. Lake Survey. These long term records yielded information suitable for the purpose of this investigation.

Discharge records at the mouths of the tributary streams emptying into these waters were inadequate. Supplementary data were secured by establishing gaging stations on the larger United States tributaries under a cooperative agreement between the U. S. Geological Survey and the International Joint Commission. These gaging stations were maintained from June 1947 to July 1948. Thus reliable records were available for a short time only.

Information on the course of pollution, particularly with reference to its crossing the boundary, was obtained from float studies made by the field staffs. The city of Detroit also made available to the Board the results of independent studies on current behavior.

FLOW CHARACTERISTICS

Information on the flow characteristics of the St. Clair River, Lake St. Clair, Detroit River, and tributaries are considered separately for each area.

St. Clair River

The flow in the St. Clair River during the 48-year period, 1900-1947, has averaged 174,000 c. f. s. The river has a mean velocity of about 5 miles per hour near its upper end in the vicinity of the Blue Water Bridge. In the lower reaches, through the South Channel, the velocity is about 2 miles per hour. At intermediate points the velocity varies irregularly between these limits.

Two islands, both in Canadian waters, split the flow in the section above Algonac. Stag Island, located about 9 miles below Lake Huron diverts approximately 64 per cent of the total river flow to the United States side of the island. Woodtick Island, situated about 22 miles below Lake Huron, diverts 83 percent of the total flow to the United States side of the island. The International Boundary is established at approximately midstream throughout this section of the river.

The St. Clair River enters Lake St. Clair through six channels. Information as to the flow in the several channels is based on current meter measurements made by the U. S. Lake Survey in 1910. Check measurements, made in 1947, indicate only minor changes in the distribution of flow since 1910. The distribution of total river flow through each channel, under average discharge conditions, is given in table 7.

Table 7 - DISTRIBUTION OF FLOW - LOWER ST. CLAIR RIVER CHANNELS

Channel	Average River Flow	
	% of Total	c f s.
Chenal Ecarte	6.0	10,400
Bassett Channel	6.2	10,800
Chematogan Channel	0.3	500
South Channel	30.0	52,200
Middle Channel	17.5	30,500
North Channel	40.0	69,600

These data show that approximately 87.5 percent of the St. Clair River flow enters the northwestern section of Lake St. Clair through the North, Middle, and South Channels. Only 12.5 percent enters the much larger portion of the lake on the Canadian side of the International Boundary through the three smaller channels.

On occasion the flow in the St. Clair River has been affected by wind action on Lake St. Clair, by a reversal of flow from the Detroit River, and by ice jams. The first two of these conditions are generally of short duration, whereas the reduction of flow by ice jams has lasted as long as one month and has at times been as great as 50 percent.

Lake St. Clair

In addition to the average discharge from the St. Clair River of 174,000 c. f. s., Lake St. Clair receives an average inflow of approximately 2,300 c. f. s. from the major tributaries listed in table 3.

At the mean stage of 574.7 feet, Lake St. Clair has an average depth of 10 feet and holds approximately 120.4 billion cubic feet of water. If there were complete and uniform displacement of the lake water by the St. Clair River flow alone it would take 8 days, under average conditions, for the incoming water to reach the Detroit River. Actually, flow conditions are influenced by those factors which have been discussed previously, and therefore the theoretical displacement time is not attained. From observations made in two instances it was found that the time of passage through Lake St. Clair was between 5 and 7 days. Other observations have indicated periods up to 16 days.

Information or the currents in Lake St. Clair is incomplete and approximate. The several float studies have produced enough data, however, for an approximate analysis of the nature of these currents.

Floats released in the narrow opening from Anchor Bay into the main part of the lake were carried in a southerly direction by relatively fast currents varying between 0.4 and 0.9 f. p. s. As the flow through Anchor Bay moves south below Point Huron it merges first with the flow from the Middle Channel and later with the flow from the South Channel. Below Point Huron, the direction and velocity of the combined current are influenced primarily by the variable winds. From this area to the head of the Detroit River the rate of travel, as determined by depth floats, varied between 0.18 and 0.47 f. p. s. On the west side of the ship channel a slight tendency toward a clockwise movement of existing currents was noted.

Measurements made by the U. S. Lake Survey indicated a mean velocity of 1.5 f. p. s. at the mouth of the South Channel and 0.9 f. p. s. in the St. Clair Flats, 1 1/4 miles below. No measurable current (less than 0.4 f. p. s.) could be detected with current meters 2 1/4 miles below the mouth of the South Channel. A float placed at this same point indicated a slight current parallel to the ship channel, toward the Detroit River.

Observations made during the several float studies provided additional information as to the effects of wind on the currents in the western sector of the lake. It was observed that with no measurable wind, or a wind from the northeast, currents moved in a southwesterly direction in the area between Point Huron and Gaukler Point. With winds from the northwest or southwest, currents moved in a southeasterly direction and crossed the International Boundary before they were diverted into the funnel-shaped approach to the Detroit River.

The relatively small flow from the St. Clair River, entering the lake on the Canadian side of the boundary, induces a slow movement of water in a southeasterly direction under the prevailing southwest wind or a wind from the northwest. Definite conclusions on current movements for specific dates cannot be reached, however, without consideration of wind direction and intensity.

No studies have been made of the lake currents under ice cover. Conclusions regarding the direction and velocity of the currents under ice are based on meager observations and reasonable interpretations. It is apparent that the water should follow a more direct course than during the months when the lake is exposed to wind action. It may be further deduced that the ice covering on such a shallow basin adds resistance to the flow. At the opening into the lake from Anchor Bay the ice sheet reduces the cross-sectional area and increases the velocity of this incoming major current. To overcome such resistance to flow the water level in Anchor Bay has been, at times, appreciably higher than at points at the lower end of the lake.

Detroit River

Discharge data, compiled by the U. S. Lake Survey, for the 13 year period 1936-1948 show the average flow in the Detroit River to be about 177,000 c. f. s. At the head, approximately 70 percent of the total flow passes to the United States side of the boundary through the larger channel between Windmill Point and Peach Island, and only 30 percent passes between Peach Island and the Canadian shore. Below Peach Island the river flow is so divided by Belle Isle that there is a boundary cross-over, which results in 70 percent of the total flow passing between Belle Isle and the Canadian shore. The current in the section of the river from the foot of Belle Isle to the head of Fighting Island is 1.5 miles per hour.

At the head of Fighting Island the river divides into three channels. Measurements made in 1948 showed that approximately 21 percent of the total river flow passes down the channel east of Fighting Island. Fighting Island Channel, which lies west of this island and is the main vessel route, carries about 52 percent of the river flow. The channel west of Grassy Island and surrounding shoals carries the remaining 27 percent of the total flow.

Point Hennepin on Grosse Ile divides the flow in the channel lying west of Grassy Island into two branches. One branch continues through to Lake Erie as the Trenton Channel, the other rejoining the main central ship channel. The Trenton Channel carries about 24 percent of the total river flow. East of Grosse Ile the river is divided into two principal channels, both of which are used for vessel traffic. The Livingston Channel carries about 26 percent, and the Amherstburg Channel about 44 percent of the river flow. Opposite Amherstburg the average current velocity is 2 miles and the maximum velocity about 4 miles per hour.

A summary of the percentage distribution of flow through the channels where measurements have been made is given in table 8, as prepared by the U. S. Lake Survey.

Table 8 - DISTRIBUTION OF FLOW - DETROIT RIVER CHANNELS
(Based on total flow of 177,000 c.f.s.)

Channel	1930		1933		1944		1948	
	%	c.f.s.	%	c.f.s.	%	c.f.s.	%	c.f.s.
Belle Isle - U.S. Side	-	-	-	-	30.9	54,750	-	-
Fighting Isl.	-	-	-	-	-	-	52	92,040
Grassy Isl. - U.S. Side	-	-	-	-	-	-	27	47,790
Fighting Isl. - Can. Side	-	-	-	-	21.7	38,430	21	37,170
Trenton Channel	22.6	39,940	24.6	43,560	23.5	41,580	-	-
Upper Livingston Channel	19.9	35,300	-	-	26.2	46,410	-	-
Amherstburg Channel	28.8	51,060	41.9	74,200	34.6	61,280	-	-

Tributaries

Tributaries of the St. Clair River, Lake St. Clair, and Detroit River carry a small total flow in comparison with that of the main watercourses. This comparison holds for average conditions rather than for those occurring under variable flood discharges.

An unusual tributary situation, however, is found with respect to flow in the Rouge River. The natural flow is supplemented by substantial volumes of municipal and industrial wastes discharging into the lower reaches. The average combined flow for the period of record was approximately 1,100 c.f.s., of which 650 c. f. s. or 59 percent was contributed by these wastes. Only 450 c. f. s. of the total flow was the natural drainage from the watershed.

A summary of the stream discharge data for the principal tributaries to the St. Clair River, Lake St. Clair, and Detroit River, as compiled from the records of the U. S. Geological Survey and the Water and Power Bureau of Canada, is given in table 9.

Table 9 - TRIBUTARY DISCHARGES - LAKE HURON-LAKE ERIE SECTION

Tributary	Location of Gaging Station	Period of Record	Discharge, c.f.s.		
			Av.	Max.	Min.
Black River	Near Fargo, Mich.	1944-1948	336	14,400	1.8
Mill Creek	Near Abbottsford, Mich.	1947-1948	138	2,360*	11
Clinton River	1/2 mile west of Mt. Clemens, Mich.	1934-1947	452	21,200	50
Sydenham River	At Alvinston, Ont.	1947-1948	211	3,710	8
Thames River	At Thamesville, Ont.	1938-1943	-	26,220	-
	At Byron, Ont.	1922-1931	1,260		
		1938-1943		31,160	
Rouge River	At Outer Drive, Dearborn, Mich.	1930-1948	97.4	13,000	2.7
Middle Rouge River	Near Garden City, Mich.	1930-1933	-	1,560*	1.4
		1947-1948	94.6	-	-
Lower Rouge River	At Inkster, Mich.	1930-1933	-	1,520*	0.3
		1947-1948	63.2	-	-
Rouge River	Above Zug Channel Detroit, Mich. (Est.)	1947-1948	450**	-	-
Huron River	At Barton, Mich.	1914-1947	391	5,840*	4.0

* Represents maximum daily average.

** Does not include municipal and industrial plant discharges.

FLOW REVERSALS

Under normal conditions the drop in the water level from Lake St.Clair through the Detroit River to Lake Erie is approximately 3 feet. Occasionally, substantial changes in barometric pressures and strong sustained winds from the east build up the water level at the western end of Lake Erie to a height as great as 8 feet above the water level at Buffalo, New York, and eliminate the differential in water elevations between Lake Erie and Lake St.Clair. At times the water level of Lake Erie, at the mouth of the Detroit River, has been even higher than the water level in Lake St. Clair.

When the water at the west end of Lake Erie is high normal downstream currents of the Detroit River are retarded, and the discharge is diminished gradually. Depending upon the intensity and duration of the wind from the east or northeast, lake water could be pushed progressively up the river until the flow was so retarded that the gradient would be reversed. It follows that after equilibrium is reached in the Detroit River, if the winds continue strong enough to raise the water level in Lake Erie above the level in Lake St.Clair at least a partial reversal of flow in the river will occur. No data are available to indicate the length of time in hours that the elevation of Lake Erie must exceed the elevation of Lake St. Clair to develop a substantial reversal of flow.

Records of the U. S. Lake Survey show thirteen instances between 1911 and 1948 when the water levels at Amherstburg or Gibraltar exceeded those at Fort Wayne, in Detroit. In nine of these instances the lower river elevations were higher than Lake St. Clair. In all these cases the high water at the mouth of the Detroit River was preceded by strong winds from the east or northeast. On five occasions the water level at the river mouth fell and then rose a second time so that normal elevations were reversed twice in an interval of less than 2 days. During these reversals the water level in Lake Erie at the mouth of the Detroit River exceeded that in Lake St. Clair by a maximum of less than one foot, except for two extreme instances when the difference reached 1-1/2 feet. The differences noted are approximate because the Lake St.Clair gages were read only three times a day, and therefore readings may not always have corresponded to the peak of the gradient reversal. The data show that reversal of the normal water level has continued over periods ranging from 2 to 12-1/2 hours. This phenomenon has been noted by trained observers on several occasions during the recent years of record.

TRANSBOUNDARY CURRENTS

The behavior of current action in the boundary waters of the Lake Huron - Lake Erie section was studied by the field staffs during the summers of 1947 and 1948. Two independent studies were made employing small wooden surface floats and sub-surface floats. Each study provided mutually supporting data to show that definite crossing of currents from one side of the International Boundary to the other occurs at various locations.

In the St. Clair River surface floats crossed from the upper sections on the Canadian side to the lower section on the United States side, some floats continuing through the North Channel and into Anchor Bay and others via the South Channel into Lake St. Clair. Floats released on the United States side of the upper river were generally carried downstream and crossed to the Canadian side between Courtright and Sombra. The floats, after reaching Lake St. Clair, followed a path along the west shore of the lake, continuing through the Detroit River and into Lake Erie. Many of these floats were observed on both sides of the river and on both shores of the western end of Lake Erie.

A number of sub-surface floats released at or near known sources of domestic and industrial pollution, along both shores in the Port Huron - Sarnia area showed no tendency to cross the International Boundary. The currents were found to follow a course somewhat parallel to the respective shore lines. Some significance may be attached to the fact that the floats submerged to depths of 15 to 20 feet, near the Canadian shore at Port Lambton, travelled down the Chenal Ecarte. Those submerged to shallower depths continued on and followed down the main or South Channel and probably across the boundary.

Current movements in Lake St. Clair are not well defined and depend largely on wind direction. Surface floats released on the west side of the lake, in general, follow paths similar to those carried down from the St. Clair River. In some instances these floats crossed the International Boundary to the Mitchell Bay area. Other floats, released at the mouth of Anchor Bay on the west shore of Lake St. Clair, in the vicinity of Nine-Mile and Martin Drains, travelled to the south shore between the Detroit River and the Belle River in Ontario. Floats released at the east end of the lake did not cross the International Boundary.

Information obtained from sub-surface float studies showed that currents from Anchor Bay merge with those from the South Channel. These currents can be expected to cross the boundary under favorable wind conditions. A strong current moving in a westerly direction along the south shore of Lake St. Clair was also observed at the approach to the Detroit River. Sub-surface floats released in Mitchell Bay showed no perceptible current direction.

Similarly in the Detroit River, surface floats crossed from side to side. In the upper river, floats crossed from the United States side through the opening between Peach Island and Belle Isle to the Canadian side. Several floats released at the mouth of the Rouge River and in the vicinity of the Detroit sewage treatment plant outlet were found on the Canadian shore opposite the upper end of Fighting Island.

Observations with sub-surface floats in the Detroit River were limited to the upper section, from Windmill Point to below Belle Isle. The floats placed less than 1,000 feet off Windmill Point showed no tendency to cross into Canadian waters, but those placed beyond 1,000 feet from the United States shore crossed the boundary between Peach Island and Belle Isle under a variety of wind conditions.

CHAPTER V

USES OF BOUNDARY WATERS

The importance of boundary water pollution arises from the multiplicity of purposes for which these waters are utilized and the resulting conflict between these uses. Article VIII of the treaty between the United States and Great Britain relating to boundary waters, signed January 11, 1909, states:

> "The following order of precedence shall be observed among the various uses enumerated hereinafter for these waters, and no use shall be permitted which tends materially to conflict with or restrain any other use which is given preference over it in this order of precedence:
> (1) Uses for domestic and sanitary purposes,
> (2) Uses for navigation, including the services of canals for the purpose of navigation,
> (3) Uses for power and for irrigation purposes".

This order of precedence is highly significant in that domestic and sanitary purposes, which are so closely related to public health, are given priority over all other uses. It is also significant that other water needs, such as for industry, for recreation, and for the support of fish and wildlife, which have come into prominence in the intervening years, are not specifically cited in the treaty. It is recognized that these waters have now come to serve this expanded category of uses. Irrespective of the uses made, the treaty requires that these boundary waters shall not be polluted on either side to the injury of health or property on the other.

These waters constitute a natural resource which has been developed to a high degree by both countries. The many and variable purposes which they now serve are discussed herein.

DOMESTIC WATER SUPPLY

Nearly 3,000,000 people, residing in some 50 communities, use the connecting waters from Lake Huron to Lake Erie as a source of domestic water supply. For this purpose alone, total water pumpage exceeds 425 million U. S. (354 million Imp.) gallons per day. Details of major public water supplies are given in table 10.

Table 10 - MUNICIPAL WATER SUPPLIES - LAKE HURON-LAKE ERIE SECTION

Municipality	Source	Population Served (Est.1948)	Daily Consumption M.G.D.	Water Treatment
Port Huron, Mich.	St.Clair R.	38,900	12.0*	D
Marysville, Mich.	"	2,400	1.7*	FD
St.Clair & Dist, Mich.	"	4,500	0.44*	FD
Marine City, Mich.	"	4,300	0.79*	FD
Algonac & District, Mich.	"	2,600	0.31*	FD
Sarnia, Ont.	"	24,000	4.39**	D
Sombra, Ont.	"	2,700	0.27**	D
Wallaceburg, Ont.	"	6,900	0.90**	FD
New Baltimore, Mich.	L.St.Clair	2,000	0.27*	FD
Fairhaven(Ira Twp.) Mich.	"	1,500	0.20*	FD
Mt.Clemens, Mich.	"	22,300	2.44*	FD
Grosse Pte.Farms,Mich.	"	8,100	1.88*	FD
Highland Park, Mich.	"	57,100	10.8 *	FD
Tilbury, Ont.	"	2,000	0.65**	FD
Belle River, Ont.	"	1,200	0.50**	FD
Tecumseh, Ont.	"	3,500	0.72**	FD
Detroit & Dist.,Mich.	Detroit R.	2,450,000	365*	FD
Wyandotte, Mich.	"	37,700	4.25*	FD
Windsor & Dist.,Ont.	"	144,300	13.0 **	FD
Amherstburg, Ont.	"	2,900	0.53**	FD

*	U. S. gallons
**	Imp. gallons
D	Chlorinated
F	Coagulated, Settled, Filtered

These water supplies are taken from various points between Lake Huron and Lake Erie. The intake locations are at various distances from shore, these locations having obviously been dictated by water quality. This means that each supply is subjected to the pollution introduced by upstream communities. By virtue of their locations at the head of these waters Port Huron and Sarnia are the only communities not subjected to this condition. It will be noted in table 10 that practically all these public water supplies are filtered and chlorinated. Port Huron and Sarnia again are exceptions, in that they chlorinate only.

SANITARY PURPOSES

These waters receive the domestic wastes from approximately 2,500,000 persons. A large portion of the water pumped for domestic consumption is used for sanitary purposes and is returned as sewage, either treated or untreated. While sewage is distributed through numerous outlets along the shores, the thickly populated Detroit-Windsor district imposes a heavier load of sewage than in any other area of these waters. The next heaviest contribution occurs in the Port Huron-Sarnia area.

NAVIGATION

Passenger and other vessels navigating the Detroit River, Lake St. Clair, and St. Clair River, or any part thereof, carried nearly 3,000,000 persons during the 1947 season of navigation. Of this total, 1,200,000 were classified as passengers, the others being listed as crew members.

The greatest concentration of vessel commerce occurred in the Detroit River, where total vessel passages exceeded 28,000, representing a net tonnage of 99,000,000. This contrasts with 77,000,000 tons through Lake St.Clair and St. Clair River. The total number of passengers carried on the Detroit River alone was approximately 1,000,000.

The disposal of sewage, refuse, oils, and ballast and bilge waters from vessels assumes importance, especially in restricted areas near sources of public water supply. It may also affect the potable water supply of other vessels.

POWER AND IRRIGATION

While power and irrigation purposes are given a place in the order of precedence established by the treaty, there are no hydro-electric power developments or irrigation projects on the Lake Huron - Lake Erie section of the boundary waters.

INDUSTRIAL USES

Industry uses boundary waters for process, steam power, cooling, and sanitary purposes in addition to that drawn from public supplies. From available data the water so used by industry, exclusive of steam power plants, amounts to nearly 1,400 M.G.D. (U.S.) Of this amount, about 1,200 M.G.D. is drawn from the Detroit River and approximately 160 M.G.D. is taken from the St.Clair River. The greatest use of industrial water is centered in the upper St. Clair River and the lower Detroit River.

Most of this industrial supply is returned as wastes directly to the boundary waters, with a minor portion going to municipal sewers. The boundary waters also receive industrial wastes of some magnitude from the principal tributaries. In addition, substantial volumes are drawn from public water supplies and ultimately reach the boundary waters by way of municipal sewers.

RECREATIONAL USES

Extensive use of these boundary waters is made for bathing at numerous points. Three types of bathing beaches, municipal, commercial, and private, operate in this area. While the number of beaches maintained by municipalities is not great they provide recreational facilities for a large segment of the population. These facilities are being expanded. As an example, the Huron-Clinton Metropolitan Authority is establishing a public beach in Lake St.Clair to accommodate 40,000 people. Commercial beaches, operated for the public by private enterprise, are located mostly in Lake St. Clair. Private beaches along the waterfront of residential properties are numerous and widely scattered. Pollution interferes with the development of many sections of the waterfront, which would be otherwise suitable for bathing.

Interest in pleasure boating is widespread in this area. Twenty-five thousand pleasure craft, of 16-foot length or larger, are registered in the Detroit area alone. Innumerable craft of smaller size also ply those waters.

FISH AND WILD LIFE

Fishing in these waters is now carried on principally by sportsmen. The St. Clair River is noted as a habitat for walleyed pike. In Lake St.Clair perch predominate in numbers, but the lake is also considered to be one of the finest fishing grounds for muskellunge. Fishing continues in Lake St.Clair through the winter, and it is not uncommon to observe over 2,000 fishing shanties on the ice. In the Detroit River sport fishing is less significant. The principal catches are perch and walleyed pike.

Commercial fishing in the United States waters of this section has not been permitted since 1909. The yield from commercial fishing on the Canadian side has declined progressively since the early nineties. The average annual amount and value of equipment used and the pounds and value of fish taken by Canadian fishermen from Lake St. Clair and the connecting rivers for the 5-year periods preceding 1914 and 1940, are:

Period	Men employed	Total value of all investment	Total catch pounds	Value of catch
1910-1914	267	$34,104	1,281,722	$71,064
1936-1940	138	42,494	733,405	39,466

Commercial and sport fishing is of greater magnitude in Lake Erie, but even here the yield from commercial fishing in the western end of the lake has declined steadily for the last 25 years.

Certain areas of these waters are natural habitats for many kinds of water fowl and attract many hunters. The marshy shoals of Lake St.Clair and the lower Detroit River, below Fighting Island, are particularly noted for migratory wild fowl. Many of these areas have been leased as private hunting grounds. Two large areas, the St. Clair Flats and Pointe Mouillee, are protected and maintained as public hunting grounds.

LEGISLATION

Administrative authority for remedial measures in pollution control is centered in the legislation enacted by various levels of governments in both countries. The several Federal, state, provincial, and municipal laws applicable to pollution control are discussed herewith.

Federal Legislation - United States

The United States Government now exercises pollution control mainly through three acts of legislation. The first of these is embodied in the provisions of Section 13 of the "Laws for the Protection and Preservation of the Navigable Waters of the United States" as included in the River and Harbor Act, approved March 3, 1899. This law prohibits the deposit of "any refuse matter of any kind or description whatever other than that flowing from streets and sewers and passing therefrom in a liquid state, into any navigable water of the United States or into any tributary of any water from which the same shall float or be washed into such navigable water."

The "Oil Pollution Act of 1924" deals specifically with deposition of oils from vessels into coastal or tidal navigable waters.

The most recent legislation enacted by the U. S. Government is Public Law 845, known as the "Water Pollution Control Act." This law, enacted June 30, 1948, is designed to "recognize, preserve and protect the primary responsibilities and rights of the States in controlling water pollution, to support and aid technical research to devise and perfect methods of treatment of industrial wastes which are not susceptible to known effective methods of treatment, and to provide Federal technical services to State and interstate agencies and to industries, and financial aid to State and interstate agencies and to municipalities, in the formulation and execution of their stream pollution abatement programs." The authority and responsibility relating to this Act are vested in the Public Health Service and the Federal Works Administration. The Public Health Service shall "in co-operation with other Federal agencies, with State water pollution control agencies, and interstate agencies, and with municipalities and industries involved, prepare or adopt comprehensive programs for eliminating or reducing the pollution of interstate waters and tributaries thereof and improving the sanitary condition of surface and underground waters."

Federal Legislation - Canada

There is no Federal legislation in Canada which is concerned with pollution of water per se. There are, however, certain statutes which indirectly deal with the question of pollution and might, under appropriate circumstances, be successfully invoked.

The "Navigable Waters Protection Act," enacted in 1927, prohibits the throwing or depositing of "any sawdust, edgings, slabs, bark or rubbish, of any description whatsoever into any river, stream or other water, any part of which is navigable or which flows into any navigable water." It further prohibits the throwing or deposition of "any stone, gravel, earth, cinders, ashes or other material or rubbish liable to sink to the bottom in any navigable non-tidal waters of Canada where there are not at all times at least eight fathoms of water."

The "Fisheries Act," enacted in 1927, prohibits the discharge of ballast, coal ashes, stones, lime, chemical substances or drugs, dead or decaying fish, and other deleterious substances either on shore, between the high and low water levels, or into "any water frequented by fish, or that flows into such water, nor on ice over either such waters."

The "Migratory Birds Convention Act," enacted in 1927, prohibits the deposit or discharge of "oil, oil wastes, or deleterious substances *** in any water frequented by migratory wildfowl, or that flows into such water, nor on ice over either of such waters."

Section 5(f) of the "National Health Act" of Canada, enacted in 1944, states that the Minister of National Health and Welfare shall enforce "any rules or regulations made by the International Joint Commission, promulgated pursuant to the treaty *** so far as the same relate to public health."

The Criminal Code of Canada, Section 221, defines a common nuisance as "an unlawful act or omission to discharge a legal duty, which act or omission endangers lives, safety, health, property or comfort of the public, or by which the public are obstructed in the exercise or enjoyment of any right common to all His Majesty's subjects. R.S., c.146,s.221." Appropriate penalties are prescribed for anyone guilty of a common nuisance.

State of Michigan

Act 245, P.A. 1929, as amended by Act 117, P.A. 1949, created a Water Resources Commission "to protect and conserve the water resources of the state, to have control over the pollution of any waters of the state and the Great Lakes, with power to make rules and regulations governing the same, and to prescribe the powers and duties of such commission; to designate the commission as the state agency to co-operate and negotiate with other governments and agencies in matters concerning the water resources of the state; and to provide penalties for the violation of this Act." The Commission consists of the Directors of Conservation, Health, Highways, and Agriculture, as well as three citizens appointed by the Governor, representing industrial, municipal, and conservation groups.

Act 98, P.A. 1913, as amended, gives the State Health Commissioner authority to supervise, visit, and control water works and sewerage systems owned and operated by municipalities or other corporations, partnerships and individuals; to make rules and regulations necessary for their control and operation; to examine and approve plans and issue construction permits for water and sewerage systems and treatment works; to issue orders to correct faulty systems or parts thereof found dangerous to individuals or to the public health generally, provided that no corporation can be deprived of right to dispose of sewage in any river after all deleterious material has been eliminated by filtration.

Act 17, P.A. 1921, makes it the duty of the Department of Conservation to provide and conserve natural resources of the state; to prevent and guard against the pollution of lakes and streams within the state and to foster and encourage the protection and propagation of fish.

Act 350, P.A. 1865, as amended, makes it unlawful for any person to put into the waters of this state any offal, blood, putrid brine, putrid fish, or filth of any description.

Act 316, P.A. 1923, as amended, provides for the construction in rural, suburban and certain urban areas of sewerage and drainage designated as county drains. The Act provides that any county drain may be used for sewage disposal by any city, village, or township for which available. After January 1945 it became unlawful to discharge any sewage or waste material capable of producing in said drain detrimental deposits, objectionable odor nuisance, injury to the drainage conduit or structures, or pollution of the waters of the state receiving the flow from said drain as to injure livestock, destroy fish life or be injurious to the public health, until all deleterious material has been removed. The Act also provides for the construction of disposal plants, filtration beds and other mechanical devices as will properly purify the flow of the drain.

Although these State Acts designate a specific agency as enforcing authority, the inclusion of the head of that agency as a member of the Water Resources Commission facilitates enforcement.

Province of Ontario

"The Public Health Act" of Ontario contains several sections dealing with pollution. Sec. 97 reads, "The Department (of Health) shall have the general supervision of all springs, wells, ponds, lakes, streams or rivers used as a source for a public water supply or for agricultural, domestic or industrial purposes with reference to their purity, together with the waters feeding the same, and shall examine the same from time to time when the necessity for such examination arises, and inquire what, if any, pollution exists and the causes thereof.

"The Department may inquire into and hear and determine any complaint made by or on behalf of a riparian proprietor entitled to the use of water, that any industrial waste or any other polluting material of any kind whatsoever which either by itself or in connection with other matter may corrupt or impair the quality of the water or may render such water unfit for accustomed or ordinary use has been placed in, or discharged into such water, or placed or deposited upon the ice thereof, or placed or suffered to remain upon the bank or shore thereof."

Sec. 98 of this same Act prohibits the discharge of pollution and reads as follows: "No garbage, excreta, manure, vegetable or animal matter or filth shall be discharged into or be deposited in any of the lakes, rivers, streams or other waters in Ontario or on the shores or banks thereof, and no industrial or other wastes, dangerous or liable to become dangerous to health or to become a nuisance, or to impair the safety, palatability or potability of the water supply of any municipality or riparian owner, shall be discharged into or be deposited in any of the lakes, rivers, streams, or other waters of Ontario, or on the shores or banks thereof.

"The owners and officers of boats and other vessels plying upon any such lake, river, stream or other water shall so dispose of the garbage, excreta, manure, vegetable or animal matter or filth upon such boats or vessels as not to create a nuisance or enter or pollute such lake, river, stream or other water."

Section 100 of "The Public Health Act" prohibits pollution of public water supplies. "No sewage, drainage, domestic, commercial or factory refuse, excremental or other polluting matter of any kind whatsoever which either by itself or in connection with other matter corrupts, pollutes or impairs or may corrupt, pollute or impair the quality of the water of any source of public water supply for domestic use in any municipality, or which renders or may render such water injurious to health shall be placed in, deposited on, or discharged into the waters, or placed or deposited upon the ice of any such source of water supply, or be placed, deposited or discharged, or suffered to remain in, on or upon the bank or shore of any such source of water supply, or in, or upon any lands adjacent to any such source, nor shall any person bathe or swim in the water of any such source of water supply."

The approval of the Department of Health is required before work is undertaken on any public water works or sewerage system. Similarly, the Department has authority to require that any water works or sewerage system be constructed, extended, enlarged or altered.

An amendment to "The Rivers and Lakes Improvement Act" passed in 1949 reads as follows: "Section 30 of The Lakes and Rivers Improvement Act is repealed and the following substituted therefor:

"In this section 'mill' means a plant or works in which logs or woodbolts are processed and includes a saw mill, a pulp mill, and a pulp and paper mill.

"Where in an action or proceeding a person claims, and but for this section would be entitled to, an injunction against the owner or occupier of a mill for an injury or damage, direct or consequential, sustained by such person, or for any interference directly or indirectly with any rights of such person as riparian proprietor or otherwise, by reason or in consequence of the throwing, depositing, or discharging, or permitting the throwing, depositing or discharging of any refuse, sawdust, chemical substance or matter from the mill or from it and other mills into any lake or river, or by reason or in consequence of any odour arising from any such refuse, sawdust, chemical substance or matter so thrown, deposited or discharged or so permitted to be thrown, deposited or discharged, the court or judge may:--

(a) refuse to grant an injunction if it is proved that having regard to all the circumstances and taking into consideration the importance of the operation of the mill to the locality in which it operates and the benefit and advantage, direct and consequential, which the operation of the mill confers on that locality and on the inhabitants of the locality, and weighing the same against the private injury, damage or interference complained of, it is on the whole proper and expedient not to grant the injunction; or

(b) grant an injunction to take effect after such lapse of time or upon such terms and conditions or subject to such limitations or restrictions as may be deemed proper; or

(c) in lieu of granting an injunction, direct that the owner or occupant of the mill take such measures or perform such acts to prevent, avoid, lessen or diminish the injury, damage or interference complained of as may be deemed proper.

"Nothing in subsection 2 shall affect any right of the person claiming the injunction to damages against the owner or occupier of the mill for any such injury damage or interference.

"Where damage from the same cause continues the person entitled to the damages may apply from time to time in the same action or proceeding for the assessment of subsequent damages or for any other relief to which by subsequent events he may from time to time become entitled.

"This section shall apply whether the injury, damage or interference is or is not a continuing one, and whether the person claiming the injunction in the action or proceeding is a plaintiff or is a defendant proceeding by way of counter-claim.

"Section 30 of 'The Lakes and Rivers Improvement Act,' as re-enacted by subsection 1 of this section, shall apply to every action or proceeding in which an injunction is claimed in respect of any of the matters mentioned in such section, including every action or proceeding in which an injunction has been granted and in which any appeal is pending."

Municipal Regulations

Municipalities are authorized to enact regulations or by-laws dealing with such local matters as control of pollution, restrictions on the use of sewers, setting rates for sewer service rates, and financing.

CHAPTER VI

WATER-BORNE DISEASES

The incidence of water-borne diseases has been utilized for many years to evaluate the effects of sewage pollution. Statistical data on these diseases are available for long periods. For purposes of this investigation these records have been confined to typhoid fever and dysenteric diseases. Both of these have been conspicuous ever since public water supplies were developed, either in the form of actual outbreaks or as potential menaces.

EPIDEMIOLOGICAL STUDIES

Consideration has been given to the findings of the 1913 survey, as recorded in the Progress Report of the International Joint Commission, dated January 16, 1914. At that time two special reports were presented as appendices: "Sanitary Conditions in Cities and Towns Situated on the United States Side of the Boundary Waters with Special Reference to Typhoid Fever" and "Typhoid Fever Statistics and Some Sanitary Facts Affecting its Undue Prevalence in Ontario." Typhoid fever death rates were given for various municipalities along the boundary waters. The excessive prevalence of this disease on the United States side, especially in the winter and spring months, was attributed in greatest measure to the sewage pollution of the interstate and international waters used as a source of public water supply. It was also stated that in Ontario the typhoid rates were excessive in most parts of the province, and they were highest of all in those municipalities situated on the international waters. Their studies led the investigating authorities to conclude that high typhoid rates in cities and towns were closely related to sewage pollution of water supplies.

Comparable statistics for 1947, presented in table 11, show that typhoid fever has been virtually eliminated. In neither Michigan nor Ontario has there been a single typhoid fever outbreak attributable to a public water supply in the past 15 years.

Table 11 - TYPHOID FEVER MORTALITY

Total Deaths and Death Rates per 100,000 Population

Municipality	1913		1920		1930		1940		1947	
	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate
State of Michigan	538	17.5	300	8.2	89	1.8	11	0.2	5	0.08
Port Huron, Mich.	5	26.6	4	15.4	2	6.4	0	0	0	0
St. Clair, Mich.	0	0	1	31.2	0	0	0	0	0	0
Marine City, Mich.	4	106.4	1	26.8	0	0	0	0	0	0
Detroit, Mich.	153	29.4	61	6.1	16	1.0	5	0.3	0	0
Wyandotte, Mich.	7	70.3	17	122.7	0	0	0	0	0	0
Monroe, Mich.	1	12.1	1	8.6	0	0	0	0	0	0
Province of Ontario	446	16.7	203	7.0	76	2.3	26	0.7	6	0.1
Sarnia, Ont.	5	43.5	3	20.5	0	0	0	0	0	0
Wallaceburg, Ont.	-	-	-	-	0	0	0	0	0	0
Chatham, Ont.	7	56.5	3	19.2	1	6.1	0	0	0	0
Windsor, Ont.	2	9.3	3	8.2	3	4.3	0	0	0	0
Amherstburg, Ont.	-	-	-	-	0	0	0	0	0	0

The 1913 report mentions the existence of "Winter Cholera," a local name for a dysenteric disease prevalent in the area and which might be termed enteritis or diarrhea. Since this disease was never reportable, and at present only diarrhea and enteritis in children under 2 years of age is reportable, there are but few epidemiological facts or little information for this disease which could be studied in connection with this survey. An epidemic of gastro-enteritis occurred in Detroit in 1926 when 45,000 persons were affected, and a total population of 1,300,000 was exposed. This incident was reported to have been traced to sewage pollution of the water supply, despite the fact that filtration and chlorination were in use.

The previous report contains no information on diseases resulting from swimming in polluted waters. In recent years an occasional case of typhoid has been attributed to swimming in this area. This is supported by evidence presented by the city of Detroit in the hearings before the International Joint Commission in 1948. About 3 years previous to this, a few cases of typhoid fever gave histories of swimming at the beaches adjacent to the Nine Mile Drain outlet into Lake St. Clair. There was strong circumstantial evidence that this was the source of infection.

No information is available on the number of cases of other diseases which might result from swimming because these are not reportable. It is believed, however, that infections of this kind are not uncommon.

EFFECT OF WATER PURIFICATION

The fact that typhoid fever from public water supplies has virtually disappeared must not be construed to mean that pollution has diminished. On the contrary, pollution of these waters has been steadily increasing, but water purification processes have made notable advances and, in general, have been able to cope with the problem of producing a safe water, even under adverse circumstances.

In the 1913 investigation epidemiological data on typhoid fever from public water supplies was given major consideration. The prevalence of this disease and the bacterial quality of the water were the main criteria for determining the intensity and effect of the pollution. Now, water-borne disease no longer plays as prominent a role insofar as public water supplies are concerned, because of the protection afforded by treatment processes. Other yardsticks must therefore be utilized to supplement the bacteriological examinations in appraising the significance of pollution. Such measures were selected and are discussed later in the report.

CHAPTER VII

SOURCES AND CHARACTER OF POLLUTION

Pollution in these boundary waters originates principally from domestic and industrial sources located along the shores. These wastes are of primary importance since their effects are imposed directly on the boundary waters, but sources of pollution on tributary streams were also studied to ascertain if the effects of those wastes were transmitted to the boundary waters.

Data on domestic wastes were secured from local, state, and provincial authorities. Where sewage treatment plants were operating the records of these were used. In others, the information was obtained from water consumption, population figures, and engineering reports.

A total of 62 industrial plants was studied, 45 being in the United States and 17 in Canada. Complete sampling and gaging studies were made at the larger industries and at those where little information was available. Where sufficient information on the quantity and character of the wastes was available from state and provincial authorities, or from some other reliable source, it was used. In all cases data and findings on the wastes were reviewed and agreed to by the industries concerned.

Vessels engaged in freight and passenger traffic contribute pollution because of their sewage and refuse disposal. Information on the number of passengers and crew carried served as the basis for determining the pollution load. Pleasure craft in large numbers also ply these waters, particularly in the Detroit River area, and contribute pollution.

DOMESTIC WASTES

All the larger municipalities are sewered, but in 17 out of a total of

39 of these the sewage is discharged untreated. In addition, there are many small communities, with waterworks systems, where sewers will ultimately be built. These constitute a potential pollution problem. Information on the main sources of domestic wastes for this section of the boundary waters is recorded in table 12. It should be noted that the figures on population do not include any equivalent for industrial wastes entering public sewers.

Table 12 - PRINCIPAL SOURCES OF DOMESTIC WASTES -
LAKE HURON-LAKE ERIE SECTION

Municipality	Receiving Stream or Lake	Population		Degree of Sewage Treatment
		Total (Est.1948)	Served by Sewers	
Port Huron, Mich.	St.Clair R.	38,900	31,100	None
Marysville, Mich.	"	2,400	1,800	"
St. Clair, Mich.	"	4,100	3,700	"
Marine City, Mich.	"	4,300	3,700	"
Algonac, Mich.	"	2,200	1,600	"
Sarnia, Ont.	"	23,000	22,000	"
Sarnia Township, Ont.	"	8,600	1,000	"
New Baltimore, Mich.	L.St.Clair	2,000	800	"
Mt. Clemens, Mich.	Clinton R.	22,300	16,700	"
St.Clair Shores, Mich.	L.St.Clair	16,300	4,100	Primary
Warren Township, Mich.	"	27,700	16,600	"
Grosse Pte.Shores,Mich.	"	1,000	300	"
Grosse Pte.Farms,Mich.	"	8,100	8,100	"
Grosse Pte.Woods,Mich.	"	3,900	3,100	"
Grosse Pte., Mich.	"	7,500	7,500	"
Grosse Pte.Park,Mich.	"	13,800	13,800	"
East Detroit, Mich.	"	15,300	13,800	"
Centerline, Mich.	"	6,500	4,800	"
Roseville, Mich.	"	14,400	8,600	"
Wallaceburg, Ont.	Sydenham R.	6,900	1,700	None

Table 12 - PRINCIPAL SOURCES OF DOMESTIC WASTES -
LAKE HURON-LAKE ERIE SECTION (continued)

Municipality	Receiving Stream or Lake	Population		Degree of Sewage Treatment
		Total (Est.1948)	Served by Sewers	
Chatham, Ont.	Thames R.	21,000	18,000	None
Tecumseh, Ont.	L.St.Clair	3,300	500	"
Detroit, Mich.	Detroit R.	1,888,200	1,878,700	Primary
Hamtramck, Mich.	"	57,700	57,700	"
Highland Park,Mich.	"	57,100	57,100	"
Dearborn, Mich.	Rouge R.	79,400	71,400	"
Melvindale, Mich.	"	6,100	6,000	None
River Rouge, Mich.	Detroit R.	20,300	20,300	Primary
Ecorse, Mich.	"	16,200	16,000	"
Allen Park, Mich.	"	4,500	4,400	"
Lincoln Park, Mich.	"	19,300	19,100	"
Wyandotte, Mich.	"	37,700	37,400	"
Riverview, Mich.	"	1,200	1,200	"
Trenton, Mich.	"	6,500	6,400	"
Riverside, Ont.	"	6,800	5,000	Secondary
Windsor, Ont.	"	119,600	115,000	None
Sandwich East, Ont.	"	13,000	1,500	"
Sandwich West, Ont.	"	7,400	1,200	"
Amherstburg, Ont.	"	3,300	1,800	"

The municipalities served by sewage treatment plants are all located in the Lake St. Clair and Detroit River areas. All but one are in the United States. The data presented in table 12 are summarized in table 13 to show these populations by areas.

Table 13 - SUMMARY OF SEWAGE COLLECTION AND TREATMENT BY AREAS

Area	Total Population (Est.1948)	Populations Served		
		By Sewers Only	By Sewers and Treatment	Total
St. Clair River	83,500	64,900	0	64,900
Lake St. Clair	170,000	37,700	80,700	118,400
Detroit River	2,344,300	125,500	2,174,700	2,300,200
Total	2,597,800	228,100	2,255,400	2,483,500

Out of a total estimated population in 1948 of 2,598,000 persons about 2,484,000 are served by sewer systems, and of these 2,255,000 are served by sewage treatment works. The Detroit plant serves 2,200,000 of this total. All these sewer systems are of the combined type, with storm and sanitary wastes carried in the same sewer. The sewerage system in Detroit is incomplete in that there are still a number of outlets discharging raw sewage directly to the river rather than to the interceptor.

The total estimated volume of municipal wastes discharged to the waters of these areas is tabulated in table 14. These totals include a variety of wastes contributed by industries located within the municipalities and connected to the public sewers. While table 13 shows a high percentage of the population being served by sewage treatment only a minor percentage is served by secondary or biological treatment.

Table 14 - VOLUME OF MUNICIPAL WASTES

Area	Volume - Million Gallons per Day			
	United States (U. S. Gallons)	Canada (Imp. Gallons)	Total - Both Sides	
			U. S. Gallons	Imp. Gallons
St. Clair River	14	4	19	16
Lake St. Clair	5	7	13	11
Detroit River	466	13	482	401
Total	485	24	514	428

Sewage Treatment Plants

The largest sewage treatment plant in this section is operated by the city of Detroit. It provides primary treatment, chlorination of the effluent, and incineration of the sludge. The plant receives the dry weather flow from the city itself and from 22 surrounding communities under contract agreements with the city. The Wayne County Board of Road Commissioners operates two sewage treatment plants on the boundary waters, serving nine communities. These are located at Wyandotte and Trenton and provide primary treatment with chlorination of the effluent and incineration of the sludge. The effluents discharge to the Detroit River. The city of Dearborn has two sewage treatment plants which discharge into the lower Rouge River. Both provide primary treatment without chlorination of the effluent, but with sludge incineration. In addition to Dearborn these plants serve all or part of three adjoining communities. On the Canadian side the town of Riverside has secondary treatment of the activated sludge type.

Details on these various plants are as follows:

Detroit Plant

Operated by:	Board of Water Commissioners, City of Detroit
Communities Served:	Detroit - Hamtramck - Highland Park - East Detroit - Ferndale - Huntington Woods - Oak Park - Pleasant Ridge - Grosse Pointe - Grosse Pointe Park - Grosse Pointe Shores - Grosse Pointe Woods - Grosse Pointe Farms - St. Clair Shores - Roseville - Hazel Park - Berkley - Clawson - Centerline - Royal Oak - Southfield Twp. - Warren Twp. - Redford Twp.
Treatment:	Sedimentation - chlorination of effluent - sludge conditioning, vacuum filtration, and incineration.
Design Flow:	420 M. G. D. (U.S.)
Present Flow	350 M. G. D. (U.S.)
Design Population:	2,400,000
Population Served:	2,200,000 (exclusive of industrial wastes)
Receiving Stream:	Detroit River

Wyandotte Plant

Operated by: Wayne County Board of Road Commissioners

Communities Served: River Rouge - Ecorse - Wyandotte - Lincoln Park - Allen Park - Riverview - Ecorse Twp. (part) - Taylor Twp. (part)

Treatment: Sedimentation - chlorination of effluent - sludge conditioning, vacuum filtration, and incineration

Design Flow: 12.5 M. G. D. (U.S.)

Present Flow: 13 M. G. D. (U.S.)

Design Population: 100,000

Population Served: 100,000 (exclusive of industrial wastes)

Receiving Stream: Detroit River

Trenton Plant

Operated by: Wayne County Board of Road Commissioners

Community Served: Trenton

Treatment: Sedimentation - chlorination of effluent - sludge to Wyandotte Plant for conditioning, vacuum filtration, and incineration

Design Flow: 2.0 M. G. D. (U.S.)

Present Flow: 1.0 M. G. D. (U.S.)

Design Population: 20,000

Population Served: 6,400 (exclusive of industrial wastes)

Receiving Stream: Detroit River

Dearborn Plants

Operated by: City of Dearborn

Communities and Population Served:

Dearborn	71,400
Inkster	5,000
Detroit	205,000
Wayne	7,500
Miscellaneous	31,500
	320,400

East Side Plant

Treatment: Sedimentation (Imhoff Tanks) - effluent to river without chlorination - sludge to west side plant for disposal.

Design Flow: 20 M. G. D. (U.S.)

Present Flow: 30 - 35 M. G. D. (U.S.)

Receiving Stream: Rouge River

West Side Plant

Treatment: Sedimentation - effluent to river without chlorination - sludge conditioning, vacuum filtration, and incineration

Design Flow: 12 M. G. D. (U.S.)

Present Flow: 8 - 10 M. G. D. (U.S.)

Receiving Stream: Rouge River

Riverside Plant

Operated by: Town of Riverside

Community Served: Riverside

Population Served: 5,000

Treatment: Activated sludge - effluent discharged without chlorination - sludge drying beds

Design Flow: 250,000 Imp. Gal. per day

Present Flow: 350,000 Imp. Gal. per day

Receiving Stream: Creek to Detroit River

It will be noted that Dearborn's east side sewage treatment plant is now seriously overloaded. The plants at Wyandotte and Riverside are now somewhat overloaded. Except for Trenton, the other plants have only limited reserve capacities.

Sources of pollution exist outside the sewered communities. Among these are the smaller urban centers, groups of summer cottages and waterfront residences. In some instances sewage is discharged directly into the boundary waters. In others it first passes through septic tanks without supplemental treatment. These afford inadequate protection.

Correction of the sewage pollution problem will require not only adequate sewage treatment plants but trunk sewers and interceptors as well. Sewage collection and treatment facilities for all urban communities should be an objective for the entire area.

Combined Sewer Overflows

In addition to the dry weather sanitary flow large volumes of deleterious wastes reach the boundary waters through storm water overflows. In combined sewers only the dry weather flow, together with some multiple of this as storm water, is intercepted and carried to the treatment plant. Usually this multiple does not exceed two to three. The excess mixture of storm and sanitary flow escapes directly to the boundary waters and tributaries.

Combined sewer overflows are numerous and widely distributed along the boundary waters and tributaries. The major ones, in the Lake Huron - Lake Erie section, discharge into Red Run and the Clinton River from South Eastern Oakland County, into Lake St. Clair from the Nine Mile and Martin Drains in Southern Macomb County, into Fox and Conner Creeks from the Detroit east side district, into the Rouge River from the Detroit west side district, and into the lower Detroit River from Wayne County drains. For Detroit alone there are 72 such overflows into the Detroit and Rouge Rivers. None of these combined sewer overflows receives any treatment, and consequently this prevents full benefit being realized from existing interceptors and treatment facilities. Intermittent pollution occurs under those conditions.

Refuse Disposal

Careless and thoughtless disposal of garbage and other kinds of refuse is an added factor in the pollution problem. These wastes add pollution, create an unsightly appearance, and present hazards to small watercraft. They originate from boats, from shore residences, and from wilful dumping by careless persons. While much refuse was formerly dumped by municipalities there is little evidence that disposal from such sources is now taking place. Other sources are difficult to control and require constant vigilance. The practice of dumping refuse in locations where it can drain into or directly enter these waters is highly objectionable, and all means should be taken to prevent it.

INDUSTRIAL WASTES

Industrial wastes are the chief source of chemical pollution, as distinguished from bacterial pollution in sewage. They are much less significant from a disease standpoint. The chief objection to many of these wastes is that they contain oils, toxic substances, or taste and odor producing compounds. Other polluting effects result from the discharge of solids, acids, oxygen-consuming wastes, and materials which impart an unsightly appearance.

Pollution by industrial wastes occurs throughout the Lake Huron - Lake Erie section but is heaviest in the upper St. Clair and lower Detroit Rivers. Table 15 lists the types of industries studied.

Table 15 - NUMBER AND TYPES OF INDUSTRIES STUDIED

Type of Industry	Number of Plants		
	United States	Canada	Total
Automotive	4	1	5
Chemical	16	3	19
Distillery	0	2	2
Gas Manufacturing	4	1	5
Metal, Miscellaneous	4	3	7
Oil	2	1	3
Paper	3	0	3
Rubber	1	1	2
Salt	2	1	3
Steel	3	1	4
Miscellaneous	6	3	9
Total	45	17	62
Coke plants - part of larger industries and included above	4	0	4

Information on the industrial wastes produced daily in the Lake Huron - Lake Erie section is contained in table 16. The flows shown include condenser and cooling waters as well as the process wastes. Where industrial wastes are discharged into tributary streams the total amount of the polluting constituents may not reach the boundary waters since natural purification tends to reduce or alter these substances. This is true particularly of organic substances such as phenols, cyanides, ammonium compounds, and oils.

Table 16 - SUMMARY OF INDUSTRIAL WASTES DISCHARGED DAILY

United States Side

Area	Total Flow-M.G.D.		Phenols (Pounds)	Cyanides (Pounds)	Ammonium Compounds (Pounds)	Oils, etc.		Susp. Solids (Pounds)
	U.S.	Imp.				U.S.Gal.	Imp.Gal.	
St.Clair River	24	20	0	0	15	40	30	33,400
Lake St.Clair	5	4	1,230	0	40	0	0	0
Detroit River	1,173	977	4,890	3,690	11,010	16,240	13,520	1,669,200
TOTAL	1,202	1,001	6,120	3,690	11,065	16,280	13,550	1,702,600
Canadian Side								
St.Clair River	133	111	220	2	0	2,450	2,040	50,300
Lake St.Clair	11	9	0	1	0	0	0	2,900
Detroit River	84	70	0	2	560	0	0	540,100
TOTAL	228	190	220	5	560	2,450	2,040	593,300
Combined - United States and Canada								
St.Clair River	157	131	220	2	15	2,490	2,070	83,700
Lake St.Clair	16	13	1,230	1	40	0	0	2,900
Detroit River	1,257	1,047	4,890	3,692	11,570	16,240	13,520	2,209,300
TOTAL	1,430	1,191	6,340	3,695	11,625	18,730	15,590	2,295,900

Origin of Wastes

The waste constituents shown in table 16 result from a variety of industrial processes, and each plant may produce one or more of these. They are discharged at both uniform rates and in batches of varying concentrations. The latter constitutes a "slug" or a "spill." The industries are listed below according to the types of wastes discharged. The general locations of their outfalls are designated by the same code letters as shown in table 1 of chapter II.

Phenolic Compounds - Phenol and phenolic equivalents are derived from by-product coke and gas plant operations, from crude oil refining, and from plants in which phenol is used as a raw material.

Phenolic compounds were found, on the United States side, in the wastes from

The Detroit Edison Company (SR)

Reichhold Chemicals Incorporated (Cl)

Michigan Consolidated Gas Company (Dt and Dt Rg)

Semet-Solvay Division of Allied Chemical & Dye Corporation (Dt)

Barrett Division of Allied Chemical & Dye Corporation (Dt Rg)

Great Lakes Steel Corporation (Dt)

Ford Motor Company (Dt Rg)

Wyandotte Chemicals Corporation (Dt)

Sharples Chemicals Incorporated (Dt)

and, on the Canadian side, in the wastes from

Imperial Oil Limited (SR)

Union Gas Company, Limited (SR)

Cyanides - Cyanides come chiefly from electric plating processes, by-product coke ovens, and from tar processing plants. They were found, on the United

States side, in the wastes from

Semet-Solvay Division of Allied Chemical & Dye Corporation (Dt)

Barrett Division of Allied Chemical & Dye Corporation (Dt Rg)

Ford Motor Company (Dt Rg)

and, on the Canadian side, from

Mueller Limited (SR)

Sydenham Trading Company (Sy)

Wallaceburg Brass, Limited (Sy)

Canadian Steel Corporation, Limited (Dt)

Ammonium Compounds - Ammonium compounds are found in the wastes of by-product coke ovens, chemical plants, gas plants, and tar processing plants. They were present, on the United States side, in the wastes from

Reichhold Chemicals Incorporated (Cl)

Michigan Consolidated Gas Company (Dt and Dt Rg)

Solvay Process Division of Allied Chemical & Dye Corporation (Dt)

Semet-Solvay Division of Allied Chemical & Dye Corporation (Dt)

Barrett Division of Allied Chemical & Dye Corporation (Dt Rg)

Ford Motor Company (Dt Rg)

Wyandotte Chemicals Corporation (Dt)

Sharples Chemicals Incorporated (Dt)

and, on the Canadian side, from

Brunner Mond Canada, Limited (Dt)

Oils and Greases - Oils and greases were found, on the United States side, in the wastes from

Pressed Metals of America, Incorporated (SR)

U. S. Rubber Company (Dt)

Michigan Consolidated Gas Company (Dt and Dt Rg)

American Brass Company (Dt)

Revere Copper and Brass Company (Dt)

Semet-Solvay Division of Allied Chemical & Dye Corporation (Dt)

Barrett Division of Allied Chemical & Dye Corporation (Dt Rg)

Great Lakes Steel Corporation (Dt)

Ford Motor Company (Dt Rg)

Darling and Company (Dt & Rg)

Fuel Oil Corporation (Dt)

Murray Corporation of America (Dt)

Wyandotte Chemicals Corporation (Dt)

Warner G. Smith Company (Dt)

Firestone Rubber and Metal Products Company (Dt)

Sharples Chemicals Incorporated (Dt)

Socony-Vacuum Oil Company (Dt)

and, on the Canadian side, from

Imperial Oil Limited (SR)

Union Gas Company Limited (SR)

Polymer Corporation (SR)

Darling and Company, Limited (Th)

Ford Motor Company of Canada, Limited (Dt)

Suspended Solids - Suspended solids were found, on the United States side, to be contributed chiefly from

Dunn Paper Company (SR)

Port Huron Sulphite and Paper Company (SR Bk)

Morton Salt Company (SR)

Diamond Crystal-Colonial Salt Division (SR and SR Pn)

U. S. Rubber Company (Dt)

Michigan Consolidated Gas Company (Dt and Dt Rg)

Solvay Process Division of Allied Chemical & Dye Corporation (Dt)

Semet-Solvay Division of Allied Chemical & Dye Corporation (Dt)

Peerless Portland Cement Company (Dt Rg)

Detroit Sulphite Pulp and Paper Company (Dt Rg)

Great Lakes Steel Corporation (Dt)

Darling and Company (Dt Rg)

Ford Motor Company (Dt Rg)

Wyandotte Chemicals Corporation (Dt)

Pennsylvania Salt Manufacturing Company (Dt)

Werner G. Smith Company (Dt)

Sharples Chemicals Incorporated (Dt)

and, on the Canadian side, from

Dominion Salt Company (SR)

Imperial Oil Limited (SR)

Polymer Corporation (SR)

Canada and Dominion Sugar Company Limited (Sy and Th)

Darling and Company Limited (Th)

Ford Motor Company of Canada Limited (Dt)

Hiram Walker & Sons Limited (Dt)

Canadian Industries Limited (Dt)

Brunner Mond Canada Limited (Dt)

Calvert Distillers (Canada) Limited (Dt)

Biochemical Oxygen Demand - Biochemical Oxygen Demand comes from organic materials of all kinds. Substantial amounts were found, on the United States side, in the wastes from

Port Huron Sulphite and Paper Company (SR Bk)
Parke, Davis & Company (Cl and Dt)
Reichhold Chemicals Incorporated (Cl)
Franklin County Sugar Company (Cl)
U. S. Rubber Company (Dt)
Detroit Sulphite Pulp and Paper Company (Dt Rg)
Solvay Process Division of Allied Chemical & Dye Corporation (Dt)
Semet-Solvay Division of Allied Chemical & Dye Corporation (Dt)
Barrett Division of Allied Chemical & Dye Corporation (Dt Rg)
Darling and Company (Dt Rg)
Michigan Consolidated Gas Company (Dt and Dt Rg)
Ford Motor Company (Dt Rg)
Werner G. Smith Company (Dt)
Sharples Chemicals Incorporated (Dt)

and, on the Canadian side, from

Imperial Oil Limited (SR)
Polymer Corporation (SR)
H. J. Heinz Company of Canada Limited (Sy)
Canada and Dominion Sugar Company Limited (Sy and Th)
Darling and Company Limited (Th)
Ford Motor Company of Canada Limited (Dt)
Hiram Walker & Sons Limited (Dt)
Brunner Mond Canada Limited (Dt)
Calvert Distillers (Canada) Limited (Dt)

The biochemical oxygen demand (B.O.D.) test of a waste is a measurement of the strength or concentration of its oxidizable organic matter. The

"Population Equivalent" value provides a basis on which industrial wastes may be compared with domestic sewage insofar as oxygen consuming qualities are concerned. The coefficient of 0.168 pound of 5-day, 20°C., B.O.D. per capita per day is used for converting the B.O.D. value to a population equivalent figure. The B.O.D. of the industrial wastes and their corresponding population equivalents are listed in table 17. These figures do not necessarily imply an equivalent bacterial pollution load.

Table 17 - POPULATION EQUIVALENT OF INDUSTRIAL WASTE DISCHARGES

Area	B.O.D. - Pounds Daily			Population Equivalent-Persons		
	U.S.	Can.	Total	U.S.	Can.	Total
St. Clair River	58,500	21,500	80,000	348,000	128,000	476,000
Lake St. Clair	94,200	30,600	124,800	561,000	182,000	743,000
Detroit River	153,900	62,500	216,400	916,000	372,000	1,288,000
Total	306,600	114,600	421,200	1,825,000	682,000	2,507,000

Miscellaneous - Miscellaneous polluting substances, as indicated, were found, on the United States side, in the wastes from

Port Huron Sulphite & Paper Company-acid-(SR Bk)

American Brass Company-acid and copper-(Dt)

Revere Copper & Brass Company-acid and copper-(Dt)

Great Lakes Steel Corporation-acid and iron-(Dt)

General Chemical Division of Allied Chemical & Dye Corporation-acid-(Dt)

Murray Corporation of America-acid and iron-(Dt)

E. I. Dupont de Nemours & Company, Incorporated-acid-(Dt)

Halowax Products Division of Union Carbide and Carbon Corporation-acid-(Dt)

Firestone Rubber and Metal Products Company-acid and iron-(Dt)

Monsanto Chemical Company-phosphorus-(Dt)

American Agricultural Chemicals Company-acid-(Dt Rg)

Detroit Michigan Stove Company-sanitary sewage-(Dt)

Great Lakes Engineering Works-sanitary sewage-(Dt)

Ford Motor Company-acid and iron-(Dt Rg)

and, on the Canadian side, from

Mueller Limited-acid and chrome-(SR)

Polymer Corporation-acid-(SR)

Ford Motor Company of Canada Limited-acid-(Dt)

Canadian Industries Limited-acid-(Dt)

Canadian Steel Corporation, Limited-acid and iron-(Dt)

Taste Examination of Industrial Wastes

Certain industrial wastes are known to cause objectionable tastes and odors in drinking waters. Many of the wastes in this section are complex in chemical structure, and insufficient information was available on their behavior when subjected to water treatment processes, particularly chlorination. Since it was believed that analytical methods alone would not give a complete measure of their taste-producing properties, it was deemed essential to undertake a special investigation of this problem.

Samples were collected from the several process wastes of the Polymer Corporation, Imperial Oil Limited, Union Gas Company Limited, and the Dow Chemical of Canada, Limited, all in the Sarnia, Ontario, area and from the Reichhold Chemicals Incorporated in Ferndale, Michigan. The examinations were made to determine the taste and odor producing properties of wastes containing phenols, and of other wastes containing aromatic substances.

In order that an industrial waste may affect a water supply

(1) the waste must be of sufficient volume and must possess sufficient potency of the taste and odor producing substances, either alone or when combined with other wastes, to withstand intermediate dilution.

(2) the constituents of the wastes responsible for the taste must be able to persist, continuously or periodically, through transportation from the point of discharge to the affected waterworks intake.

From this special investigation the following conclusions were reached:

(1) The wastes from all five industries involved in this special investigation possess taste-producing properties, but the reaction of each varies with dilution and chlorination.

(2) High phenol concentrations were present in specific wastes of the Reichhold Chemicals Incorporated and the Imperial Oil Limited.

(3) Chlorination tests on the various wastes for development and persistence of tastes were made, using varying dosages of chlorine. These showed that the measure of phenolic material, regardless of analytical techniques, does not necessarily reveal its ability to produce taste upon chlorination.

(4) Several wastes had their taste-producing properties enormously enhanced by chlorination. These included the phenol distillate from Reichhold Chemicals Incorporated, and the caustic lye wash (C.L.W.) draw-off and "411" agitator wastes from Imperial Oil Limited. These wastes also showed extreme variation in the taste produced as the chlorine-to-waste ratio was varied, and demonstrated that no limited examination would adequately assay the potential importance of the waste as a source of taste and odor

difficulties. This is particularly exemplified by the Reichhold wastes.

(5) The cracking coil effluent water from Imperial Oil Limited, when chlorinated, showed a progressive decrease in its taste-producing characteristics with increasing dosages.

(6) In the Polymer Corporation isobutylene (I.P.S.) acid waste the taste intensity was substantially unchanged by partial or complete chlorination.

(7) Polymer Corporation light end (L.E.R.) caustic and Canadian Synthetic Rubber (C.S.R.) caustic wastes had taste and odor producing properties which not only were quickly rendered innocuous by simple chlorination, but which also could not survive simple aerobic dilution at normal pH.

(8) It was shown that the waste from the Polymer Corporation oil separator had its maximum taste in the unchlorinated control sample, and that a complete range of chlorination did not increase the taste above that shown in the control sample.

WASTES FROM NAVIGATION

Studies were made to determine the amount and significance of pollution resulting from navigation on the boundary waters. The volume of water-borne commerce for the 1947 season was reported to be at an all time high for a peace time year and was therefore used as the basis for these studies. Data on vessel passages and freight and passenger traffic were compiled from the records of the U. S. Corps of Engineers.

Sanitary wastes from vessels are confined mostly to the navigation channels, and discharges occur intermittently along the entire route. Wastes are also discharged while vessels are in port. In some instances retention tanks have been provided for storage of sewage while at dock. When sewage is so stored the collection is deposited shortly after departure from the restricted area. This practice has value in protecting the harbor areas, but it introduces a mass of sewage in a limited area on the navigation routes. Other vessels following shortly thereafter may draw this contaminated water for domestic purposes.

No vessels operating in this section were found to have retention tanks, except some large passenger boats and ferries. The design of most vessels makes it impracticable to collect all wastes at one point, but this should create no special obstacle in providing storage tanks. The volume of such wastes is particularly significant from large passenger vessels, some of which have a capacity up to 2,200 passengers and 200 crew members. The U. S. Public Health Service estimates the quantity of sanitary wastes to be 30 gallons per person per 24-hour day.

Pollution contributed by vessels navigating these waters is significant in quantity. Nearly three million persons traversed these waters or parts of them in 1947. The estimated total equivalent population, for a full 24-hour period, at the height of the navigation season averaged 3,900. The estimated discharge from this population was 120,000 U. S. (100,000 Imp.) gallons of sanitary wastes for each day.

Navigation companies report that garbage and other refuse are stored in containers on board vessels and subsequently dumped overboard in open bodies of water or at shore points. This practice pollutes the water and causes complaints about the fouling of bathing beaches. While no specific data are available concerning the amount of garbage produced on vessels, the value of 0.5 pound per capita per day, accepted as an average for cities, might be applied here also. On this basis, the estimated amount of garbage per day at the peak of the navigation season would average 2,000 pounds. The maximum amounts produced during the months of July and

August are approximately one and one-half times the average calculated value.

Bilge water includes seepage through the hull, leakage in water lines and from pumps and machinery, and wash-down water. It accumulates at the lowest level of the vessel and contains lubricating oils, greases, and other like wastes. This mixture is discharged intermittently by the bilge pumps, usually when the vessel is in motion. The quantity of this waste is highly variable, and it is difficult to determine the quantity of oils discharged with it. Based upon records of bilge pump operation and of oil consumption, the total quantity of oil discharged from all vessels has been conservatively estimated to be about 40 U. S. gallons per day.

Ballast water is used to effect stability of the vessel under various operating conditions. It is pumped into and discharged from tanks built in the fore and after peaks and in the bottom of the vessel. Common practice is to take ballast water from overboard while unloading and to discharge it as the cargo is received. Under certain conditions ballast water is also pumped overboard while en route to lighten the load and increase the speed. Thus, contaminated water may be taken aboard at one point and transferred into a relatively clean area elsewhere. This practice is hazardous, chiefly in that pollution may be discharged in the vicinity of water supplies and bathing beaches.

Regulations in many areas prohibit the discharge of any waste from a vessel in the vicinity of water supply intakes and bathing beaches. These restricted areas should be adequately designated and every care exercised by vessel operators to ensure that these requirements are strictly observed.

WASTES FROM DREDGING

The deposition of solids in the lower Rouge River originates from soil washings on the watershed and from the large volumes of domestic and industrial wastes discharged into the river. This has made it necessary for the U. S. Corps of Engineers to develop an annual program of maintenance dredging as an aid to navigation. The average annual expenditure of Federal funds for these operations is now $75,000.

Coincident with this investigation of boundary waters pollution, attention was focused on the dumping from these operations. The city of Wyandotte, Michigan, which obtains its raw water supply from the lower Detroit River, contended in June 1947 that the dumping of dredged material in the river above Fighting Island was at least partly responsible for difficulties in water treatment. The State of Michigan also concerned itself with this matter, and on October 22, 1947, the Stream Control Commission passed a resolution protesting against this practice. A preliminary study was undertaken by the Board, and a report was later made to the Commission. It was concluded at that time that some potential hazard to downstream water supplies existed.

This led to a request by the District Engineer of the U. S. Corps of Engineers, Detroit District, to the U. S. Public Health Service for a comprehensive study on the pollutional effect of these dredging operations. Accordingly, the Public Health Service undertook a special study in cooperation with the field staff of the International Joint Commission between June 1 and September 2, 1948. The findings and recommendations were reported to the District Engineer for his information and guidance in planning future dredging operations.

The Rouge River dredgings consist of a mixture of sewage solids and industrial waste solids with alluvial deposits. A typical analysis of the bottom deposits showed a high content of organic matter, iron oxide, oil, and coliform bacteria. The material was dark in color and had an offensive odor. When dumped, it released oil to the surface of the water.

These dredging operations are conducted each year for a period of approximately 50 days. The volume of material removed approximates one-half million cubic yards a year. This material contained an average daily quantity of 11.4 tons of iron (Fe), 17,400 (U.S.) gallons of oil, 2,710 pounds of sulphides, 325 tons of volatile solids, and a B. O. D. population equivalent of 373,000. These operations involve the transfer of a heavy mass of pollution from a tributary to the boundary waters.

CHAPTER VIII

POLLUTION EFFECTS ON BOUNDARY WATER QUALITY

The effects of pollution have been measured by bacteriological, chemical, and physical examinations. These analytical tests were supplemented by relevant data on municipal water supplies, bathing beaches, sewage effluents, combined sewer overflows, and industrial wastes. All this information has shown the extent and intensity of pollution in both the boundary waters and tributaries, the changes which take place in the zones between the sources of pollution, and the suitability of these waters for the various uses discussed previously.

Throughout the investigation, a total of 8,101 surface water samples were taken for bacteriological examinations and 10,784 for chemical tests. Analyses were made in the field laboratories at Sarnia, Windsor, and Detroit.

EXPLANATION OF LABORATORY TESTS

The analytical determinations used in the survey are listed below. An explanation of each is given as an aid in interpreting the significance of the tests.

Bacteriological Examinations

Bacterial examinations were limited to the confirmed test for the coliform group of bacteria. These bacteria are normal inhabitants of the intestines of warm-blooded animals and are discharged in large numbers in human feces. This test is the most delicate and specific means of approximating the density of a group of bacteria which are always present in large numbers in sewage and are, in general, relatively few in number in other stream pollutants. The results are reported as "most probable number" (M.P.N.) per

100 ml. This is commonly known as the "M.P.N. Index."

Lake Huron water, not subject to direct contamination, is relatively free of coliform bacteria, less than 5 M.P.N. per 100 ml. Raw sewage may contain about 25 million M.P.N.

Chlorides

All fresh waters contain chlorides, the normal amount varying in different regions. An increase above normal is an indication of contamination from outside sources. Chlorides in water may be derived from both sewage and industrial wastes. The normal content of Lake Huron water is about 7 p.p.m. Chlorides increase the soap consuming power of water and adversely affect boiler feed water. They are not removed by the usual water purification processes.

Phenolic Compounds

Phenols and phenolic equivalents were measured by the Gibbs Method with modifications. Phenols react with chlorine to produce intensely aromatic compounds. These compounds, even when highly diluted, may give a taste and odor to the water which is variously described as medicinal, chemical, or iodoform. They taint fish and are toxic to fish depending on their concentration. Normal water contains no phenolic compounds.

Ammonium Compounds

Ammonium compounds include free ammonia and ammonium salts, but they do not include albuminoid ammonia or organic nitrogen. The ammonium ion tends to combine with chlorine to form chloramines in public water supplies and thereby increases the chlorine demand. Erratic chlorine demand constitutes a public health hazard. Ammonium compounds are also toxic to fish.

Lake Huron samples showed only trace quantities. Any substantial increase may be attributed to sewage and industrial wastes of the organic type.

Chlorine Demand

The test for chlorine demand is an indicator of the amount of organic matter present. It increases with addition of sewage and other organic pollutants. The difficulty and cost of water chlorination are increased where there is a high chlorine demand.

Temperature

The temperature of water influences the solubility of oxygen and the rate of oxidation and purification.

Dissolved Oxygen

The amount of dissolved oxygen contained in unpolluted water fluctuates with the temperature. A deficiency of oxygen is replaced by solution of oxygen from the atmosphere. There is a saturation value for each temperature. At 18°C this is 9.54 p.p.m. of dissolved oxygen. Values below the saturation level indicate the presence of polluting organic substances which are absorbing oxygen from the water. The extent of this deficiency is one index of the degree of organic pollution. Substantial reduction in dissolved oxygen causes suffocation of fish.

Biochemical Oxygen Demand (B.O.D.)

The biochemical oxygen demand test indicates the amount of oxygen required for stabalization of the decomposable organic matter. The time and temperature used are 5 days and 20° C, respectively. The figure for Lake Huron water, unaffected by pollution, is less than 1 p.p.m. In contrast, raw sewage has a B.O.D. of about 200 p.p.m.

Turbidity

This test is a measure of the appearance of the water as affected by suspended material, such as silt and finely divided organic matter.

Solids

The analyses for solids include total and suspended as well as their volatile portions. The former measures the solids in solution and in suspension. The total volatile solids indicate the amount of organic matter. Both sewage and industrial wastes are significant sources of solids. Domestic sewage carries 0.2 pound of suspended solids per capita per day. Solids in industrial wastes vary with the type of industry.

The effects of suspended solids in water are reflected in difficulties associated with water purification, deposition in streams, interference with navigation, and injury to the habitat of fish.

Hydrogen Ion Concentration (pH)

The pH value of water indicates its relative acidity or alkalinity. It is a measure of intensity rather than of quantity. A pH of 7.0 is the neutral point. Higher values are in the alkaline range, and lower in the acid range. The pH of these waters is about 8. Any appreciable departure from this indicates the influence of acid or alkaline wastes.

Alkalinity

Alkalinity represents the concentration of carbonates, bicarbonates, hydroxides, and occasionally borates, silicates, and phosphates. Calcium and magnesium are the two metals which account for most of the alkalinity. Industrial waste discharges high in alkalinity will affect the hardness of the water. Hardness is an economic factor in the use of water supplies, either for domestic or industrial purposes.

Oils and Ether-Soluble Materials

These results include oils and all other ether-soluble materials such as tarry substances and greases. The presence of these pollutants renders water difficult and sometimes impractical to treat, either for industrial or domestic use. Oils make the beaches unsightly and the waters unfit for bathing. They coat water craft and are a hazard to wild fowl.

Tastes and Odors

Determinations of taste and odor quality and intensity indicate the degree of consumer acceptance of a water supply. They aid in the search for substances responsible for tastes and odors whether due to waste discharges or to organic material naturally present in the stream. Results for odors are expressed as threshold odor numbers, these increasing with the increase in dilution required to cause disappearance of the odor. Tastes are determined in a like manner, using dilutions of chlorinated samples until the taste is barely perceptible. It is expressed as the dilution needed. Both taste and odor are described by quality or characteristics as well as intensity.

Cyanides

Cyanides are probably the most toxic substances in industrial wastes. Very low concentrations are fatal to fish. Cyanides are not natural components of surface waters.

ANALYTICAL RESULTS OF THE 1913 INVESTIGATION

Reference to the investigation of these waters in 1913 reveals that the nature, character and extent of the pollution found at that time differed materially from those in the 1946-1948 survey. Pollution, in the earlier investigation, came almost entirely from sanitary sewage and from vessels.

It is interesting to note in the "Report of the Consulting Sanitary Engineer upon Remedial Measures" that "none of the industrial processes are likely to result in the discharge of waste products in sufficient quantity to seriously affect the condition of the river water. * * * It seems quite likely that this subject of industrial wastes may soon become sufficiently pressing to require detailed investigation and possibly some sort of regulation." The automotive industry, which has been responsible for the major industrial growth in this area during the period 1913 to 1946, was still in its infancy. Many of the chemical and other industries existing today were either not yet established or were operating on a much smaller scale.

The findings in the earlier investigation were based entirely on B. coli examinations. The results were expressed in terms of the "Phelps Index," as the approximate number of B. coli in 100 c.c. of the sample when calculated from the results of single tube dilution tests. The "coliform group" as recorded in this report may be considered to correspond to the "B. coli group" as used formerly. Laboratory procedures have been refined in the intervening years in an effort to obtain greater precision in the estimation of the number of coliform organisms. While comparisons in results of the two investigations can be approximate only, it may be assumed that the M.P.N. figures used in the present investigation are 2.4 times greater than numbers which would be given by the "Phelps Index."

In the "Final Report of the International Joint Commission" conditions in the Lake Huron-Lake Erie section in 1913 were summarized as follows:

"The examination showed that the waters of Lake Huron at the head of the river would be practically free from B. coli were it not for the pollution from vessel sewage. Samples taken about 10 miles up the lake showed absence of B. coli even in 100 c.c., while the water at the lower end, where vessel pollution is concentrated, showed an average of 9 B. coli per 100 c.c. Below the towns of Port Huron and Sarnia the waters of the St. Clair River for a stretch of about 34 miles are quite unfit for drinking purposes unless extensively treated, the B. coli content found in the river water exceeding 200 per 100 c.c. The pollution below these towns is due to the combined effects of the discharge of untreated sewage from vessels and the towns along the shores. Any tendency toward self-purification of the river by natural agencies is counterbalanced by the sewage and drainage from the small villages and residences along its course.

"Lake St. Clair, which receives the discharge of the river, showed less evidence of pollution. Natural agencies promote in the lake a purification not found in the river.

* * * * *

"The extensive pollution of the Detroit River is perhaps better indicated by saying that at its head the B. coli count is approximately 5 per 100 c.c., and in the lower portions just below Amherstburg it reaches the enormous figure of 10,592 B. coli per 100 c.c.

"The pollution in the Detroit River is occasioned by the discharge of raw sewage from its riparian communities, notably the city of Detroit, and by the sewage from vessels.

"The investigations * * * show that while the waters of the western end of Lake Erie are extensively polluted by the flow of the Detroit River, this pollution does not extend past the islands which separate this end from the remainder of the lake.

"Lake Erie, outside of this polluted area and the polluted areas at the mouths of its tributaries and its littoral waters, affords a remarkable instance of self-purification. The purity of the main body of the lake was amply established by examination of its water at several widely separated stations."

ANALYTICAL RESULTS OF THE 1946-1948 INVESTIGATION

In the present investigation the analytical results show that pollution is due mainly to domestic and industrial wastes. Sampling covered the area extending from the southern end of Lake Huron to the western end of Lake Erie. Tables 18 to 22, inclusive, present summaries of the results of bacterial, chemical, and physical analyses of samples taken during the 1946-1948 survey. The tables show maximum and minimum results, averages for chemical and physical tests, and medians for bacterial results. The median is the value equalled or exceeded by exactly half of the values in the given list.

Lake Huron

The analytical summary for samples taken at the southern end of Lake Huron is presented in table 18. The coliform results are plotted in figure 3. The water is of good sanitary quality and relatively free from domestic and industrial pollution. Median coliform M.P.N. values were generally in the range of 5 or less per 100 ml., with a maximum value of 130. The quality of this water remains the same as in 1913. These results are not uncommon for clean surface waters.

Chemical and physical tests support the bacteriological findings. Dissolved oxygen values ranged between 9 and 11 p.p.m., while the B.O.D. reached a maximum of 3.2, with average values of 0.5 to 1.5 p.p.m. Phenols attained a maximum of 4 p.p.b., with most of the averages showing only trace quantities. Turbidity results were also low, the maximum being 10 p.p.m., and the averages varying between 2 and 4 p.p.m. Oils were observed only occasionally.

98A

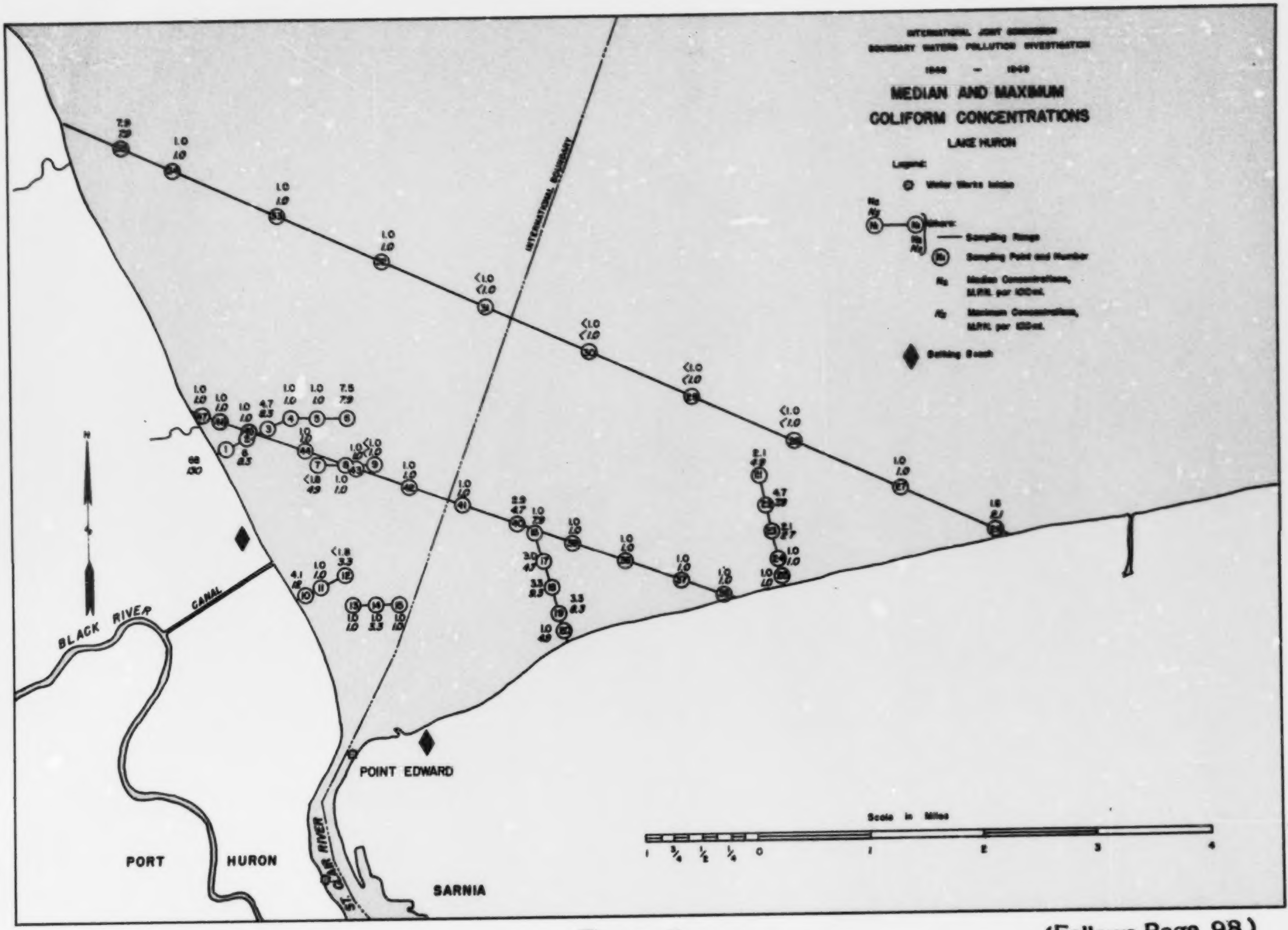

INTERNATIONAL JOINT COMMISSION
BOUNDARY WATERS POLLUTION INVESTIGATION
1946 – 1948
MEDIAN AND MAXIMUM
COLIFORM CONCENTRATIONS
LAKE HURON
Legend:
Water Works Intake
Sampling Range
Sampling Point and Number
Median Concentrations, M.P.N. per 100ml.
Maximum Concentrations, M.P.N. per 100ml.
Bathing Beach
INTERNATIONAL BOUNDARY
POINT EDWARD
SARNIA
PORT HURON
BLACK RIVER
CANAL
ST. CLAIR RIVER
N
Scale in Miles
1 3/4 1/2 1/4 0 1 2 3 4

Figure 3

(Follows Page 98)

Table 18 —SUMMARY OF AVERAGE ANALYTICAL RESULTS— LAKE HURON

Sampling Range & Location	Station (Miles)		Coliforms MPN per 100ml	Chlorides ppm	Phenol ppb	[illegible] ppm	[illegible] ppm	Temp. °C	D.O. ppm	BOD 5 day ppm	Turbidity ppm	pH	Alk. ppm	[illegible] ppm	[illegible]				[illegible]	Total Solids ppm	
															No.	[illegible]	No.	[illegible]		Total	Volatile
	0.0							U. S. Shore													
Off Gratiot Beach	0.1	Average	Median 33	6.6	0.7	-	0.10	-	10.6	1.0	7.0									93	62
Point No. 1.		Maximum	130	7.1	3	-	0.25	-	11.9	2.4	9.0									110	66
		Minimum	< 1.0	6.2	0	-	0.10	-	10.0	0.80	6.0									75	57
		No. of Samples	4	3	4		3		3	4	3									3	3
		Average	Median 6	6.9	0.5		0.10		10.4	2.0	7									81	55
Range continued -	0.25 mi	Maximum	9.2	7.1	2		0.10		10.6	2.8	10									110	66
Sample Point No. 2.		Minimum	< 1.0	6.6	0		0.10		10.3	1.0	4									59	46
		No. of Samples	4	3	4		3		3	4	3									3	3
Range continued	0.5 m.	Average	Median 3.7	6.9	0.75		0.15		10.3	1.4	6									97	55
Sample Point No. 3		Maximum	6.5	7.1	3		0.50		10.4	2.2	7									116	60
		Minimum	1.0	6.6	0		0.05		10.0	0.6	3									60	44
		No. of Samples	4	3	4		3		3	4	3									3	3
Range continued	0.75m.	Average	Median 1.0	7.2	0		0.05		10.6	1.1	3									94	57
Sample Point No. 4.		Maximum	1.0	7.2	0		0.15		11.2	2.0	4									108	73
		Minimum	< 1.0	7.1	0		0.05		10.2	0	3									88	60
		No. of Samples	4	3	4		3		3	4	3									3	3
Range continued	1.0 m.	Average	Median 1.0	7.2	0		0.10		10.0	1.4	3									79	55
Sample Point No. 5.		Maximum	1.0	7.2	0		0.15		10.6	2.0	3									108	73
		Minimum	< 1.0	7.1	0		0.05		9.3	0	3									80	56
		No. of Samples	4	3	4		3		3	3	3									3	3
Off Gratiot	1.5	Average	Median 1.0	7.6	0	-	0.12		10.1	1.0	3									98	62
Beach - Point No. 6.		Maximum	3.1	7.9	0		0.15		10.6	2.0	3									124	75
		Minimum	< 1.0	7.1	0		0.10		9.6	0	1									73	44
		No. of Samples	4	3	4		3		3	4	3									3	3
Below Light Ship	0.0				U.S. SHORE																
Below Light Ship	0.25	Average	Median < 1.0	7.1	0.5		0.05		10.1	1.4	3									92	57
Point No. 7.		Maximum	4.0	7.1	3		0.10		10.4	2.0	4									116	78
		Minimum	< 1.0	7.1	0		0.05		9.8	0.4	1									60	42
		No. of Samples	4	3	4		3		3	4	3									3	3
Below Light Ship	1.0	Average	Median 1.0	7.5	0.5		0.10		10.0	1.5	3									96	64
Point No. 8.		Maximum	1.0	7.9	3		0.10		11.1	2.6	4									162	74
		Minimum	< 1.0	7.1	0		0.10		9.2	0	3									74	54
		No. of Samples	4	3	4		3		3	4	3									3	3
Edge of Channel		Average	Median < 1.0	6.9	0		0.07		10.1	0.85	5									90	65
Below Light Ship	1.25	Maximum	< 1.0	7.1	0		0.10		10.5	2.2	5									122	76
Point No. 9.		Minimum	0	6.5	0		0.05		9.6	0	4									74	52
		No. of Samples	4	3	3		3		3	4	3									3	2
U.S. Shore 1.25 m.	0.0				U.S. SHORE																
above entrance to	0.1	Average	Median 4.1	7.0	1		0.10		10.3	1.50	4									85	61
St. Clair River -		Maximum	15	7.0	2		0.15		11.2	2.2	5									112	68
Point No. 10.		Minimum	1.0	6.6	0		0.05		9.4	0	3									75	54
		No. of Samples	4	3	4		3		3	4	3									3	3
U.S.Shore 1.25 m	0.25	Average	Median 1.0	7.5	0		0.05		10.0	0.67	4									88	49
above entrance to		Maximum	1.0	7.5	0		0.10		10.5	2.0	4									118	70
St Clair River - Point No. 11.		Minimum	< 1.0	7.1	0		0.05		9.4	0	3									58	30
		No. of Samples	4	3	4		3		3	4	3									3	3
Range Continued - Sample	0.5	Average	Median < 1.0	7.5	0.5		0.07		10.1	0.57	3									101	68
Point No. 12.		Maximum	3.5	7.5	3		0.10		10.5	1.1	3									180	76
		Minimum	< 1.0	7.1	0		0.05		9.6	0	3									88	60
		No. of Samples	4	3	4		3		3	4	3									3	3

Table 18 —SUMMARY OF AVERAGE ANALYTICAL RESULTS- LAKE HURON (continued)

Sampling Range & Location	Station (miles)		Coliform MPN per 100ml	Chlorides ppm	Phenols ppb	Ammonia as N ppm	Chlorine Dem. ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm	Turbidity ppm	pH	Alk. ppm	Cl2 ppm	Threshold Odor, Cold				Taste	Total Solids ppm	
															Raw		Chlorinated				
															No.	Nature	No.	Nature		Total	Volatile
U.S.Shore 1.5 m.	0.6							7.5,	[illegible]												
above entrance	0.4	Average	Median 1.0	5.5	1		0.12		10.6	1.7	4									90	60
to St. Clair River		Maximum	1.0	6.8	3		0.20		10.4	2.3	4									114	76
Sample Point No. 13.		Minimum	< 1.0	0.8	0		0.08		9.4	1.4	3									68	6
		No. of Samples	4	3	4		3		3	4	3									3	3
Range continued	0.6	Average	Median 1.0	6.9	0.5		0.10		9.9	1.8	3									97	
Sample Point No. 14.		Maximum	2.8	7.1	2		0.15		10.3	2.5	3									130	72
		Minimum	< 1.0	6.8	0		0.08		9.6	0.4	3									63	48
		No. of Samples	4	3	4		3		3	3	3									3	3
Range continued	0.8	Average	Median 1.0	6.4	1.2		0.08		10.1	1.5	4									95	60
Sample Point No. 15.		Maximum	1.0	6.8	4		0.15		10.3	1.9	4									133	84
		Minimum	< 1.0	6.8	0		0.08		9.8	1.4	3									60	58
		No. of Samples	4	2	4		2		2	4	2									2	2
Can. Shore 2 m. east	1.0	Average	Median 1.0	6.7	1		0.18		10.1	1.8	7									101	56
of Ent. to St. Clair River		Maximum	7.9	7.1	2		0.20		10.4	2.0	8									124	66
Sample Point No. 16.		Minimum	1.0	6.2	0		0.06		10.0	0.6	6									78	46
		No. of Samples	4	3	4		3		3	4	3									3	3
Range continued	0.75	Average	Median 3	7.1	0.8		0.13		9.8	1.4	10									115	70
Sample Point No. 17.		Maximum	4.7	7.1	2		0.20		10.1	2.1	11									132	80
		Minimum	1.0	7.1	0		0.08		9.4	1.0	9									98	78
		No. of Samples	4	3	4		3		3	4	3									3	3
Range continued	0.5	Average	Median 8.3	7.1	0		0.12		9.9	1.07	10.5									115	77
Sample Point No. 18.		Maximum	9.3	7.1	0		0.15		10.6	1.8	12									144	88
		Minimum	0	7.1	0		0.10		9.4	0.60	9									86	68
		No. of Samples	4	2	4		3		3	4	2									2	2
Range continued	0.25	Average	Median 3.3	7.1	0.66		0.15		10.1	1.3	7									90	64
Sample Point No. 19.		Maximum	8.3	7.1	2		0.20		10.2	1.6	8									120	84
		Minimum	1.0	7.1	0		0.05		10.0	1.0	4									60	44
		No. of Samples	3	3	3		3		2	2	2									2	2
Range continued		Average	Median 1.0	6.4	0.06		0.20		9.8	1.2	15									147	81
Sample Point No. 20.	0.10	Maximum	49	7.1	2		0.40		10.2	1.4	28									186	98
		Minimum	1.0	5.7	0		[illegible]		9.4	1.0	3									108	64
		No. of Samples	3	2	3		3		2	3	2									2	2
	0.0						CANADIAN SHORE														
Canadian Shore	0.1	Average	Median 3.1	6.8	0		0.12		9.8	1.0	10									138	78
4 m. east of Ent.		Maximum	49	7.1	0		0.22		10.2	1.2	17									154	84
to St.Clair River		Minimum	1.0	6.6	0		0.05		9.4	0.8	3									116	60
Sample Point No. 21.		No. of Samples	3	2	3		3		2	3	2									2	2
Range continued	0.25	Average	Median 4.7	6.8	0		0.12		9.9	1.1	7									117	75
Sample Point No. 22.		Maximum	7.8	7.1	0		0.20		10.2	1.3	7									129	82
		Minimum	1.0	6.5	0		0.10		9.6	1.0	6									108	68
		No. of Samples	3	2	3		3		2	3	2									2	2
Range continued		Average	Median 2.1	6.1	0.08		0.12		9.8	1.0	8									127	73
Sample Point No. 23.	0.5	Maximum	27	6.2	2		0.13		10.0	1.6	8									134	80
		Minimum	< 1.0	6.0	0		0.08		9.6	0.4	8									120	66
		No. of Samples	3	2	3		3		2	3	2									2	2
Range continued		Average	Median 1.0	6.4	0.06		0.10		9.7	0.8	8									115	72
Sample Point No. 24.	0.70	Maximum	1.0	6.6	2		0.10		9.8	1.2	8									116	74
		Minimum	< 1.0	6.2	0		0.10		9.6	0.2	7									114	70
		No. of Samples	3	2	3		3		2	3	2									2	2

Table 18 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – LAKE HURON (continued)

Sampling Range & Location	Station (Miles)		Coliforms MPN per 100 ml	Chlorides ppm	Phenols ppb	Ammonia N ppm	Chlorine Demand ppm	Temp °C	D.O. ppm	B.O.D. 5 day ppm	Turbidity ppm	pH	Alk ppm	[illegible] ppm	Threshold Odor, Cold – Raw – No.	Threshold Odor, Cold – Raw – Values	Threshold Odor, Cold – Chlorinated – No.	Threshold Odor, Cold – Chlorinated – Values	Taste	Total Solids ppm – Total	Total Solids ppm – Volatile
Range continued		Average	Median 1.0		0.7		0.07		9.8	2.0											
Sample Point	1.0	Maximum	1.0	0.5	0		0.10		10.0	1.4											
No. 26.		Minimum	1.0		0		0.05		9.8	0.8										116	56
		No. of Samples	1	1	2		2		2	2										1	1
	0.0								CANADIAN SHORE												
[illegible]	0.1	Average	Median 1.6		0		0.10		10.5	1.4											
Shore 6 miles		Maximum	2.1		0				10.6	2.0											
East of [illegible]		Minimum	1.6		0				10.4	0.8											
to [illegible] to Lake View		No. of Samples	2		2		1		2	2											
Reach U.S. Shore No. 25.																					
		Average	Median 1.0		0		0.08		10.7	0.8											
Sample Point No. 27.	1.0	Maximum	1.0		0				11.0	1.4											
		Minimum	1.0		0				10.4	0.4											
		No. of Samples	2		2		1		2	2											
Sample Point No. 28.	2.0	Average	Median < 1.0		0		0.08		9.2	0.4											
		Maximum	< 1.0		0				9.3												
		Minimum	< 1.0		0				9.2												
		No. of Samples	2		2		1		2	1											
Sample Point No. 29.	3.0	Average	Median < 1.0		0		0.1		9.8	0											
		Maximum	< 1.0		0				9.8												
		Minimum	< 1.0		0				9.4												
		No. of Samples	2		2		1		2	1											
Sample Point No. 30.	4	Average	Median < 1.0		0		0.1	0	9.2	0.4											
		Maximum	< 1.0		0				9.4	0.8											
		Minimum	< 1.0		0				9.0	0											
		No. of Samples	2		2		1		2	2											
	475						INTERNATIONAL BOUNDARY														
Range continued	5.0	Average	Median < 1.0		0		0.08		9.3	0.5											
(Main Shipping Channel)		Maximum	< 1.0		0				9.4	0.6											
Sample Point No. 31.		Minimum	< 1.0		0				9.2	0.4											
		No. of Samples	2		2		1		2	2											
Range continued	6.0	Average	Median 1.0		0		0.05		9.8	0.6											
(Main Shipping Channel)		Maximum	1.0		0				10.2	1.0											
Sample Point No. 32.		Minimum	< 1.0		0				9.4	0.2											
		No. of Samples	2		2		1		2	2											
Range continued		Average	Median 1.0		1		0.05		10.0	0.6											
Sample Point No. 33.	7.0	Maximum	1.0		2				10.4	1.0											
		Minimum	< 1.0		0				9.6	0.2											
		No. of Samples	2		2		1		2	2											
Sample Point No. 34.	8.0	Average	Median 1.0		0		0.08		9.7	0.7											
		Maximum	1.0		0				9.8	1.0											
		Minimum	< 1.0		0				9.6	0.4											
		No. of Samples	2		2		1		2	2											
Sample Point No. 35.	8.5	Average	Median 7.9		0		0.05		9.4	0.2											
		Maximum	7.9		0				9.6	0.4											
		Minimum	7.9		0				9.2	0											
		No. of Samples	2		2		1		2	2											
	9.0							U. S.	SHORE												
Opp. Shore 2.5 m. east	0.0 0.10	Average	Median 1.0		0		0.05	Canadian Shore	10.7	1.6											
of [illegible]		Maximum	1.0		0				11.0	1.6											
Reach U.S. Shore		Minimum	1.0		0				10.4	1.6											
Sample Point No. 36.		No. of Samples	2		2		1		2	2											

Table 18 —SUMMARY OF AVERAGE ANALYTICAL RESULTS— LAKE HURON (continued)

Sampling Range & Location	Station (Miles)		Coliform MPN per 100 ml	Chlorides ppm	Phenol ppb	Ammonia N ppm	Chlor. Dem. ppm	Temp. °C	D.O. ppm	BOD 5 day ppm	Turbidity ppm	pH	Alk. ppm	[illegible] ppm	Threshold Odor, Cold				Taste	Total Solids ppm	
															Raw		Chlorinated				
															No.	Odors	No.	Odors		Total	Volatile
Range continued	0.60	Average	Median 1.0		1		0.10		10.6	1.10											
Sample Point No. 37.		Maximum	1.0		2				10.8	1.4											
		Minimum	1.0		0				10.2	0.80											
		No. of Samples	2		2		1		2	2											
Sample Point No. 38.	1.0	Average	Median 1.0		0		0.10		10.1	0.70											
		Maximum	1.0		0				11.0	0.80											
		Minimum	1.0		0				9.2	0.60											
		No. of Samples	2		2		1		2	2											
Sample Point No. 39.	1.5	Average	Median 1.0		0		0.05		10.7	1.0											
		Maximum	1.0		0				11.2	1.2											
		Minimum	1.0		0				10.2	0.80											
		No. of Samples	2		2		1		2	2											
Sample Point No. 40.	2.0	Average	Median 2.9		0		0.10		10.5	0.80											
		Maximum	4.7		0				10.6	0.90											
		Minimum	1.0		0				10.0	0.40											
		No. of Samples	2		2		1		2	2											
	2.5						INTERNATIONAL BOUNDARY														
From Can. Shore 2.5 m	2.8	Average	Median 1.0	-	0		0.10		9.8	0.50											
east of Rte. to SSE to		Maximum	1.0		0				10.5	0.80											
Ecoundale Beach - U.S.		Minimum	1.0		0				9.0	0											
Shore. Sample Point No. 41.		No. of Samples	2		2		1		2	2											
Main Shipping Channel	3.3						INTERNATIONAL BOUNDARY - Main Shipping Channel.														
	3.5	Average	Median 1.0		0		0.10		9.8	0.7											
Range Continued		Maximum	1.0		0				10.2	0.8											
Sample Point No. 42.		Minimum	1.0		0				9.4	0.6											
		No. of Samples	2		2		1		2	2											
							MAIN SHIPPING CHANNEL														
Range continued	3.9	Average	Median 1.0		0		0.10		9.8	0.10											
Sample Point No. 43.		Maximum	1.0		0				9.8	0.20											
		Minimum	1.0		0				9.5	0											
		No. of Samples	2		2		1		2	2											
Sample Point No. 44.	4.0	Average	Median 1.0		1		0.05		9.6	0.6											
		Maximum	1.0		2				9.8	1.2											
		Minimum	1.0		0				9.4	0											
		No. of Samples	2		2		1		2	2											
Sample Point No. 45.	4.5	Average	Median 1.0		0		0.05		9.3	0.4											
		Maximum	1.0		0				9.4	0.6											
	—	Minimum	1.0		0				9.2	0.2											
		No. of Samples	2		2		1		2	2											
From Can. Shore 3.8 m	4.75	Average	Median 1.0		0		0.05		9.5	0.40											
east of Rte. to SSE to		Maximum	1.0		0				9.6	0.8											
Ecoundale Beach US		Minimum	1.0		0				9.4	0											
Shore: Sample Point No. 46.		No. of Samples	2		2		1		2	2											
Range continued	4.90	Average	Median 1.0		0		0.05		9.0	0.20											
Sample Point No. 47.		Maximum	1.0		0				9.4	0.40											
		Minimum	1.0		0				8.6	0											
		No. of Samples	2		2		1		2	2											
	5.0							U.S. SHORE													

St. Clair River

The summary of analytical results for the St. Clair River is given in table 19. Figure 4 shows the median coliform results and figure 5 the average phenol results. These two analyses are the most significant for these waters. Oils are also a problem here. They were observed frequently in quantity but are not measurable by river sampling.

The water entering the St. Clair River from Lake Huron is of good sanitary quality. This good quality is continued, as indicated by the low coliform results, in the middle third of the stream from Lake Huron to the communities of St. Clair and Moore, a distance of about 11 miles. The high coliform counts show heavily polluted zones near the respective shores of this upper section, reflecting the untreated sewage discharged from Port Huron, Marysville, and Sarnia. This bacterial pollution is higher on the United States side because of a greater concentration of population than on the Canadian side. The median M.P.N. values near the United States shore increased from 5 above the Black River to 5,400 below Port Huron. The coliform results at the mouth of the Black River showed a median M.P.N. value of 16,000 per 100 ml., and a maximum of over 1,100,000. Thus, the Black River introduces a heavy coliform concentration in spite of any intended beneficial effect of the canal feeding Lake Huron water into this river. Near the Canadian shore the M.P.N. values increased from 5 at the entrance of the river to 930 below Sarnia and further rose to 2,400 at Corunna.

Proceeding downstream from St. Clair and Moore, the coliform results show a pronounced development toward a uniform distribution across the entire river. Between St. Clair and Marine City the stream is considerably reduced in cross-section, causing a swifter current and increased turbulence. This tends to mix the water and partially diffuse the polluting matter, a conclusion which was supported by surface float studies. The bacterial load is sustained at a high level of 2,400 M.P.N. on the United States side by raw sewage introduced at St. Clair and Marine City. At a corresponding point on the Canadian side, the bacterial load shows some diminution but continues at a moderately high level of 860 M.P.N.

As the flow divides in the vicinity of Algonac the band of shore pollution from the United States side is carried into the North and Middle Channels, and from the Canadian side into the Chenal Ecarte. The flow of the less concentrated band in the center of the St. Clair River tends to follow the South Channel into Lake St. Clair.

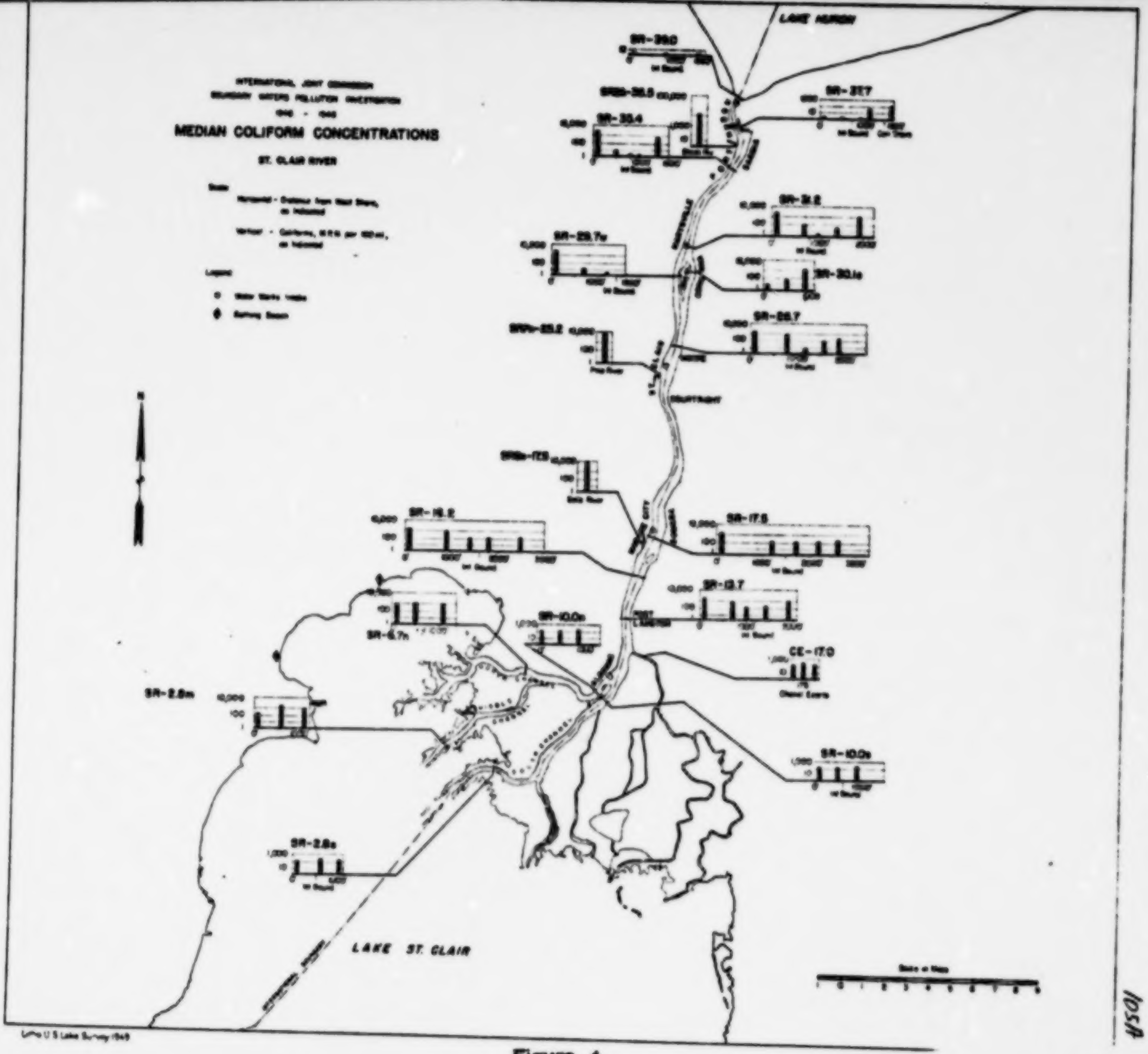
The water leaving the St. Clair River carries a bacterial load of coliform organisms 200 times greater than the same water as it enters from Lake Huron. This condition prevails in spite of the effects of natural purification in this stretch of 28 miles.

Phenols are not normally present in clean waters. Lake Huron water, for the most part, was free from this substance. An occasional sample, taken from the navigation channel showed phenol, but the source of this was uncertain.

Since phenols come almost entirely from industrial plants these discharges will not necessarily be uniform. This is demonstrated by the variable results obtained in the river samples. High values were found on both sides. These can be attributed, on the Canadian side, to known sources. However, high values on the United States side could not be traced to known sources on that side. They may be due to slugs from some unknown origin. In the upper reaches of the river a maximum of 140 p.p.b. was found on the Canadian side, and a maximum of 340 p.p.b. on the United States side.

Below the constricted section there is evidence of diffusion and distribution in the central band of the stream. All channels leading from the St.Clair River carry varying amounts of phenol. A few high results, ranging from 160 to 400 p.p.b., were obtained in the North and South Channels, respectively, and 100 p.p.b. in Chenal Ecarte.

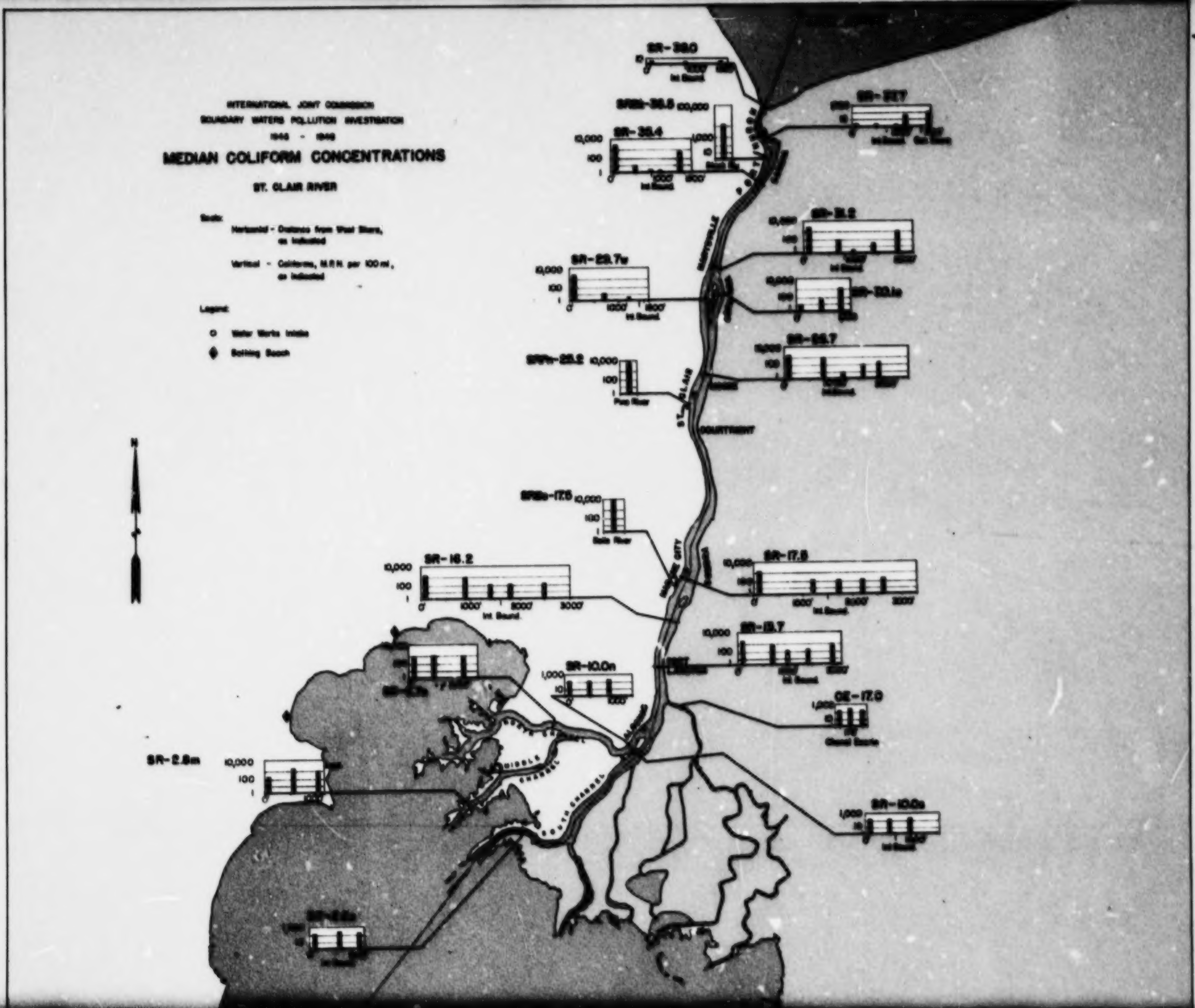
Oils, greases, and other similar substances were observed in all parts of the river at different times. Other analytical results show less significant effects. The high average dissolved oxygen and low average B.O.D. results indicate that the oxygen balance is not materially disturbed by the discharges of oxygen consuming wastes. Objectionable conditions, however, are created in many local areas due to the presence of wastes.


INTERNATIONAL JOINT COMMISSION
BOUNDARY WATERS POLLUTION INVESTIGATION
MEDIAN COLIFORM CONCENTRATIONS
ST. CLAIR RIVER
Scale
Legend
LAKE HURON
SR-39.0
SR-37.7
SR-33.4
SR-31.2
SR-29.7u
SR-30.1e
SR-26.7
SR-17.5
SR-16.2
SR-13.7
SR-10.0n
SR-6.7n
CE-17.0
SR-10.0s
SR-2.8n
SR-2.8s
COURTRIGHT
LAKE ST. CLAIR
Scale in Miles

Litho U.S. Lake Survey 1949

Figure 4

A



INTERNATIONAL JOINT COMMISSION
BOUNDARY WATERS POLLUTION INVESTIGATION
1946 - 1948

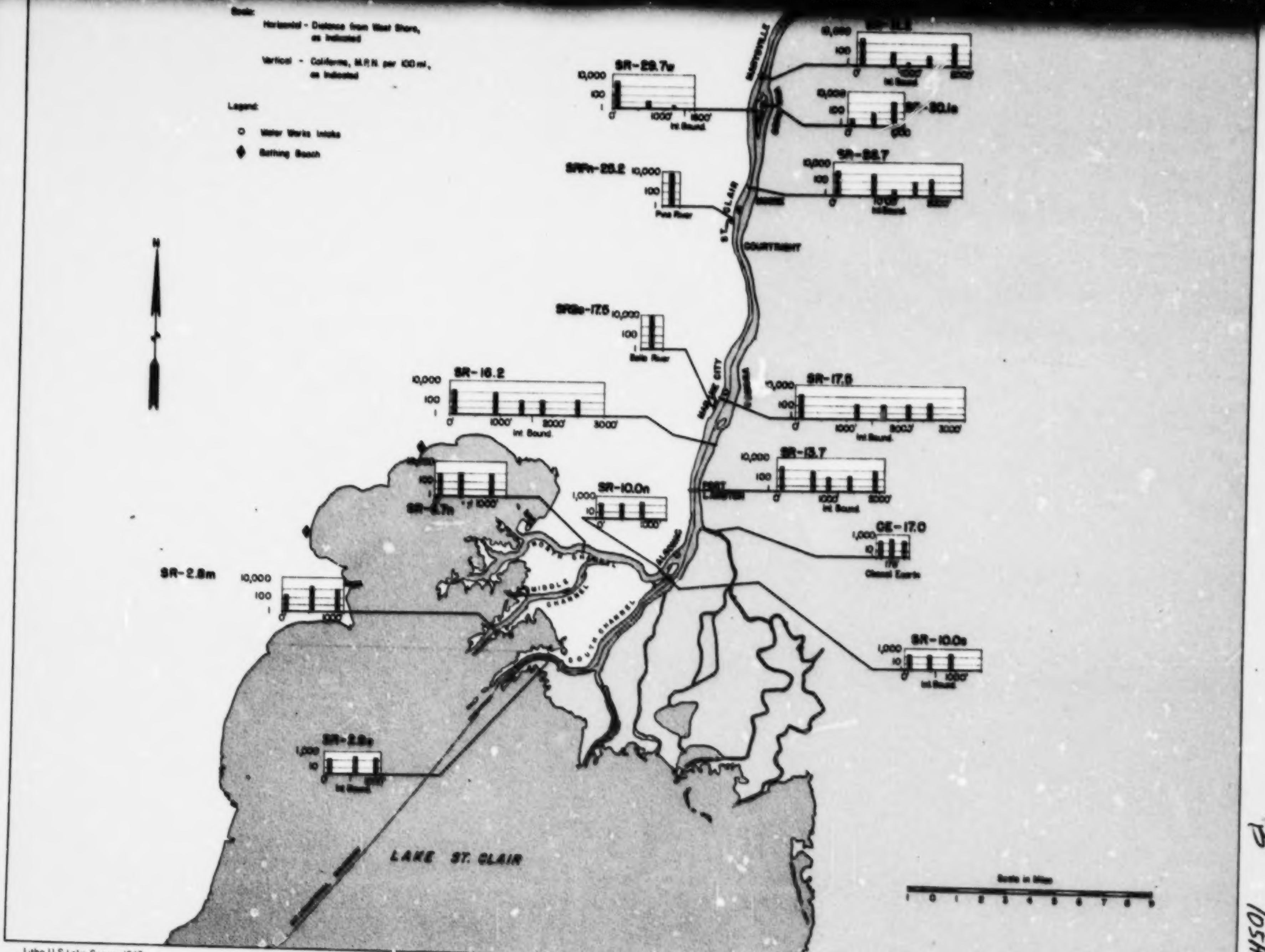
MEDIAN COLIFORM CONCENTRATIONS

ST. CLAIR RIVER

Scale:
Horizontal - Distance from West Shore, as indicated
Vertical - Coliforms, M.P.N. per 100 ml, as indicated

Legend:
○ Water Works Intake
◆ Bathing Beach

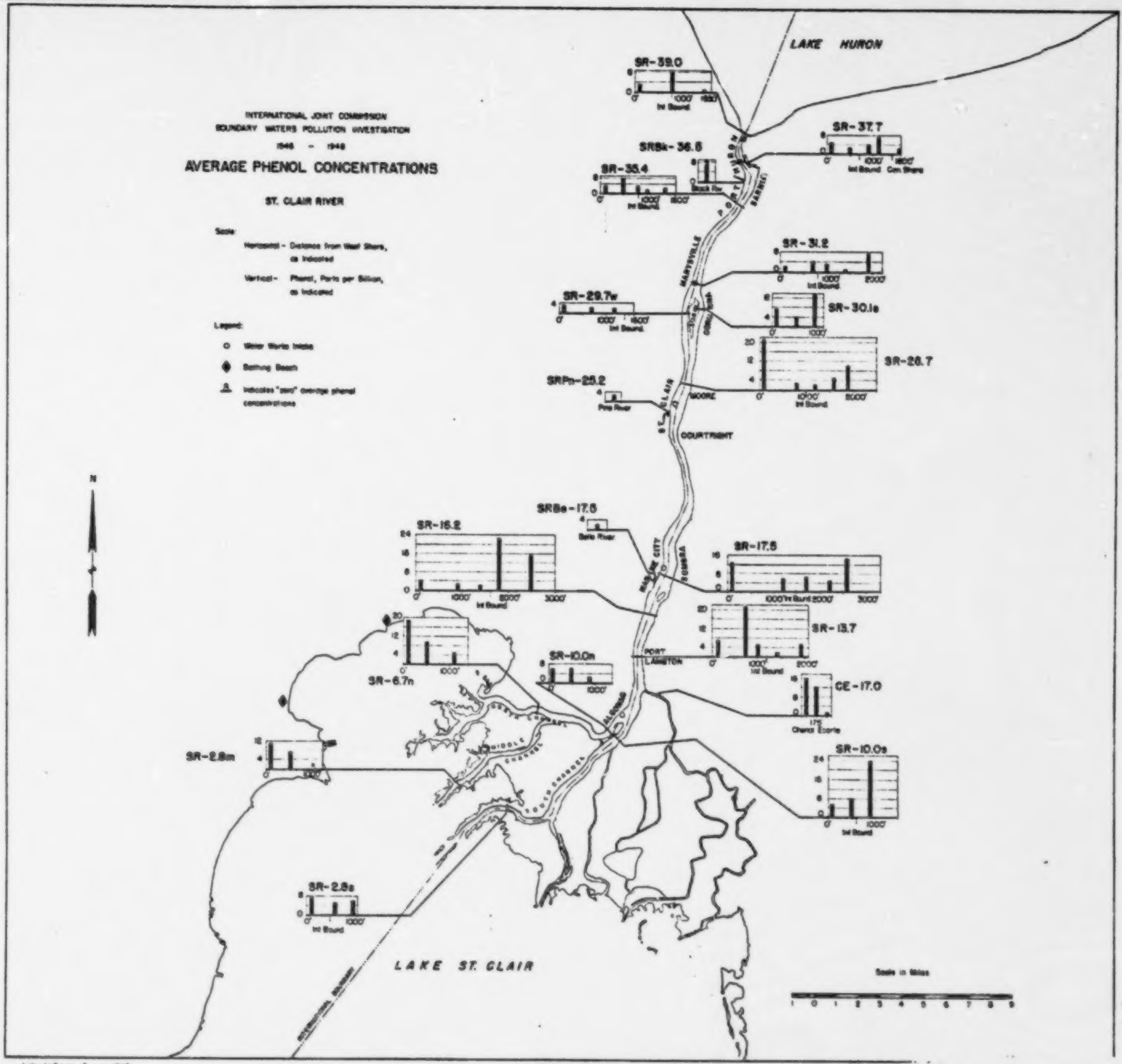
SR-38.0
SRBb-36.5
SR-35.4
SR-37.7
SR-31.2
SR-29.7w
SR-30.1e
SR-25.7
SRPn-25.2
SRBe-17.5
SR-17.8
SR-16.2
SR-13.7
SR-10.0n
OE-17.0
SR-10.0s
SR-2.8m
100,000
10,000
1,000
100
10
1
0
1000'
2000'
3000'
Int. Bound.
Pine River
Belle River
Chenal Ecarte
PORT HURON
MARYSVILLE
ST. CLAIR
COURTRIGHT
MARINE CITY
MIDDLE CHANNEL
SOUTH CHANNEL
N


Scale:
Horizontal - Distance from West Shore, as Indicated
Vertical - Coliforms, M.P.N. per 100 ml, as Indicated
Legend:
○ Water Works Intake
◆ Bathing Beach
N
SR-29.7w
SR-30.1e
SR-28.7
SRRr-28.2
Pine River
SRBs-17.5
Belle River
SR-16.2
SR-17.5
SR-13.7
SR-10.0n
CE-17.0
SR-10.0s
SR-2.8m
SR-2.8s
10,000
1,000
100
10
1
0'
1000'
2000'
3000'
Int. Bound.
MARYSVILLE
ST. CLAIR
COURTRIGHT
MARINE CITY
SOMBRA
PORT LAMBTON
ALGONAC
NORTH CHANNEL
MIDDLE CHANNEL
SOUTH CHANNEL
LAKE ST. CLAIR
Scale in Miles
1 0 1 2 3 4 5 6 7 8 9

Litho U S Lake Survey 1949

Figure 4

(Follows Page 106)


LAKE HURON
SR-39.0
SR-37.7
SRBk-36.8
SR-35.4
SR-31.2
SR-30.1e
SR-29.7w
SR-26.7
SRPn-25.2
SRBe-17.5
SR-17.5
SR-16.2
SR-13.7
CE-17.0
SR-10.0n
SR-10.0s
SR-6.7n
SR-2.8n
SR-2.8s
Int Bound
Can Shore
Black Riv
Pine River
Belle River
Chenal Ecarte
PORT HURON
SARNIA
MARYSVILLE
CORUNNA
ST. CLAIR
MOORE
COURTRIGHT
MARINE CITY
SOMBRA
PORT LAMBTON
ALGONAC
LAKE ST. CLAIR
INTERNATIONAL BOUNDARY
Scale in Miles
N

INTERNATIONAL JOINT COMMISSION
BOUNDARY WATERS POLLUTION INVESTIGATION
1946 - 1948

AVERAGE PHENOL CONCENTRATIONS

ST. CLAIR RIVER

Scale:
Horizontal - Distance from West Shore, as Indicated
Vertical - Phenol, Parts per Billion, as Indicated

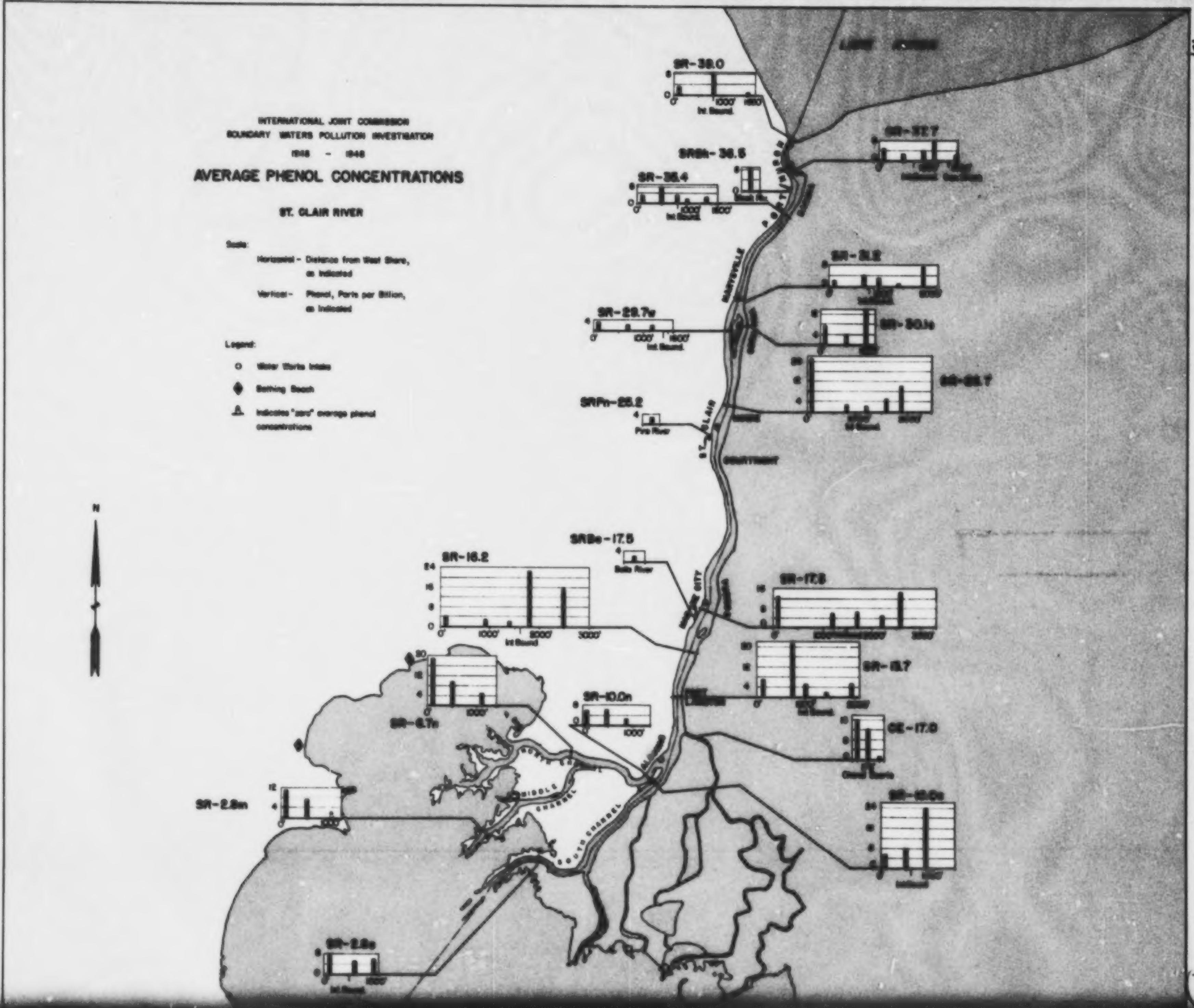
Legend:
○ Water Works Intake
◆ Bathing Beach
△ Indicates "zero" average phenol concentrations

Litho U S Lake Survey 1949

Figure 5

105B

A


LAKE HURON
SR-39.0
SR-37.7
SRBh-36.5
Black Riv.
SR-36.4
SR-31.2
MARYSVILLE
SR-30.1e
SR-29.7w
SR-28.7
SRPn-25.2
Pine River
ST. CLAIR
SRBe-17.5
Belle River
SR-16.2
SR-17.8
CITY
SR-13.7
CE-17.0
SR-10.0n
SR-10.0s
SR-6.7n
SR-2.8n
SR-2.8s
MIDDLE CHANNEL
SOUTH CHANNEL
0'
1000'
1500'
2000'
3000'
Int. Bound.
N

INTERNATIONAL JOINT COMMISSION
BOUNDARY WATERS POLLUTION INVESTIGATION
1946 - 1948

AVERAGE PHENOL CONCENTRATIONS

ST. CLAIR RIVER

Scale:

Horizontal - Distance from West Shore, as Indicated

Vertical - Phenol, Parts per Billion, as Indicated

Legend:

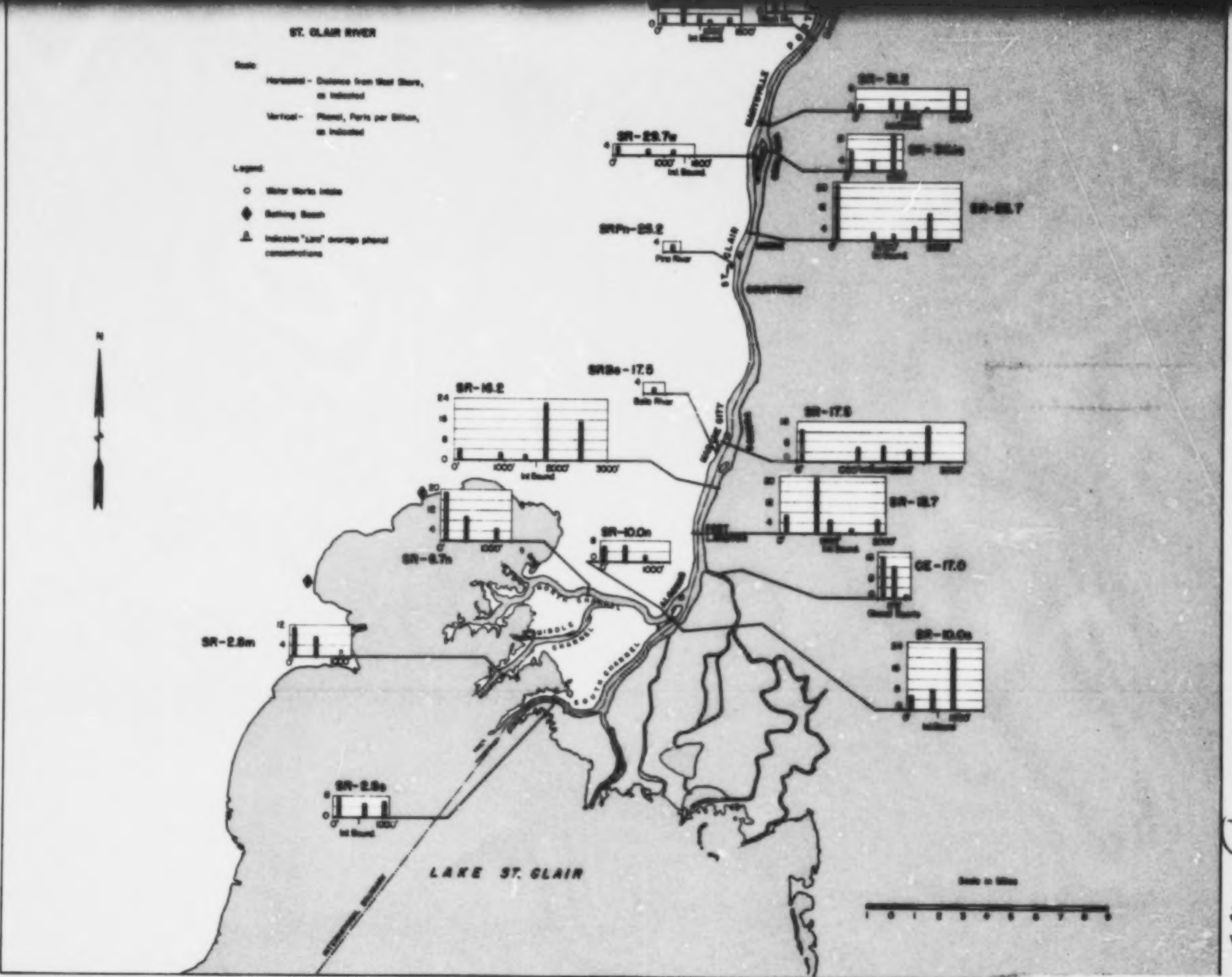
○ Water Works Intake

◆ Bathing Beach

△ Indicates "zero" average phenol concentrations

B

B 105B


ST. CLAIR RIVER
Scale
Horizontal - Distance from West Shore, as indicated
Vertical - Phenol, Parts per Billion, as indicated
Legend
○ Water Works Intake
◆ Bathing Beach
▲ Indicates "zero" average phenol concentrations
N
SR-31.2
SR-29.7w
SR-28.7
SRPn-25.2
Pine River
ST. CLAIR
COURTRIGHT
SRBe-17.5
Belle River
MARINE CITY
SR-17.5
SR-16.2
SR-13.7
SR-10.0n
SR-8.7n
CE-17.0
SR-10.0s
SR-2.8m
SR-2.9s
Int Bound.
MIDDLE CHANNEL
SOUTH CHANNEL
LAKE ST. CLAIR
Scale in Miles
1 0 1 2 3 4 5 6 7 8 9

Litho U S Lake Survey 1949

Figure 5

(Follows Page 1

Table 19. -SUMMARY OF AVERAGE ANALYTICAL RESULTS- ST. CLAIR RIVER

Sampling Point	Mileage Index No.	Distance from West Shore		Coliforms MPN per 100ml	Chlorides ppm	Phenols ppb	Amm. as N ppm	Chlor. Dem. ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm	Turbidity ppm	pH	Alk. ppm	Oils ppm	Threshold Odor, Cold: Raw No.	Raw Nature	Chlorinated No.	Chlorinated Nature	Taste	Total Solids ppm: Total	Volatile
	S.R.39.0	0.0	Average						U.S. Shore													
Pt. Gratiot Light	S.R.39.0	100'		Median 4.1	6.7	3.0	.02	.30	17.1	9.7	.66	10	8.0	79				1.3				
to Point Edward			Maximum	1,100	16.6	40	.18	.31	24.0	11.1	3	34	8.2	82		1.3		1.3			200	
Light			Minimum	1	2.9	0	0	.29	9.0	6.4	0	2	7.8	78		1		1.3				
			No. of Samples	20	13	15	10	3	12	19	19	13	3	3		3	3	1		8	1	
	S.R.39.0	800'						International Boundary														
	S.R.39.0	800'	Average	Median 2.3	6.32	8.5	.01	.23	17.0	9.9	.74	11	7.9	79.6		0.4		1.3				
			Maximum	8.1	11.3	75	.10	.32	23.5	11.2	3	21	8.1	84		1.3		1.3			170	
			Minimum	1	4.2	0	0	.10	9.0	6.7	0	5	7.8	77		0		1.3				
			No. of Samples	17	20	[illegible]	7	3	9	15	17	8	3	3		3	2	1		8	1	
	S.R.39.0	1500'	Average	Median <3.6	4.9	.67	0	.29	16.3	9.9	.65	9	7.9	79.3		1.1	-	1.3		-		
			Maximum	170	8.0	10	.04	.31	24.0	11.6	2.3	28	8.2	82		1.3	-	1.3		-	212	
			Minimum	<1.8	3.0	0	0	.28	9.0	6.2	0.18	2	7.8	78		1	-	1.3				
			No. of Samples	20	13	17	10	3	12	17	17	11	3	3		3	3	1		8	1	
	S.R.39.0	1650'						Canadian Shore														
Port Huron W.W.	S.R.37.7	0.0 100'	Average	Median 4.5	5.2	4.7	.004	U.S. .31	Shore 16.0	9.9	.66	7	7.7	80.4		1		2.2				
to Canadian Shore			Maximum	16,000	8.0	80	.04	.42	23.5	11.4	2.6	18	8.0	86		4		2.2			178	
Dock Ruins to Black			Minimum	0.67	2.8	0	0	.20	7.5	6.8	0	2	7.4	78		0		2.2				
Spar			No. of Samples	27	13	26	10	5	14	21	27	11	6	6		5	5	1		8	1	
	S.R.37.7	300'																				
			Average	Median 8	5.2	2.5	0	.25	13.0	10.1	1.12	6	7.8	79.8		1		2.2				
			Maximum	43	8.0	17	0	.30	23.0	11.4	4	19	8.2	82		5		2.2			168	
			Minimum	0.46	3.7	0	0	.10	8.0	6.4	0	4	7.6	77		0		2.2				
			No. of Samples	24	11	20	6	5	10	16	21	7	5	5		5	5	1		5	1	
	S.R.37.7	700'						International Boundary														
	SR.37.7	900'	Average	Median 8.5	5.4	3.7	.003	.25	14.8	10.2	.89	7	7.8	79.		0						
			Maximum	23	8.0	27	.02	.31	22.5	11.6	2.3	19	8	82		1		1			162	
			Minimum	0.63	4.2	0	0	.10	8.0	6.8	0	3	7.6	77		0		0				
			No. of Samples	23	12	21	7	5	11	19	23	6	5	5		5	4	5		6	1	
	SR.37.7	1100'	Average	Median 79	5.5	7.5	0	0.24	14.3	10.2	0.83	8	7.9	79.4		0.3						
			Maximum	1,500	8.0	90	0	0.31	22.5	11.6	3.0	18	8.2	82		2		0			184	
			Minimum	<1.8	3.7	2	0	0.05	7.5	6.2	0	5	7.7	78		0		0				
			No. of Samples	24	11	21	6	5	10	16	22	7	5	5		4	4	4		4	1	
	SR.37.7	1600'	Average	Median 120	6.5	2.1	0	0.25	-	10.1	0.96	7	7.8	79.6		0						
			Maximum	>16,000	24.0	15.0	0.008	0.30	22.5	11.6	7.0	19	8.4	84		1		0			180	
			Minimum	<3.6	3.1	0	0	0.10	7.5	6.8	0.30	3	7.4	78		0		0				
			No. of Samples	28	14	28	10	8	14	21	27	11	5	5		4	4	3		8	1	
		[illegible]						Canadian Shore														
Black River at Mouth	SRBk 36.5		Average	(Median) 16,000	18	8.7		5.7	11.1	5.0	6.6	11	7.2	92		0					225	62
			Maximum	1,100,000	33	35		9.2	13.5	7.5	70	20	7.4	110		0					240	62
			Minimum	16,800	9.1	0		0	9.5	0	2	3	7.0	80		0					210	62
			No. of Samples	10	6	11		8	4	4	10	2	4	6		4					2	1
Port Huron Coal	SR.35.4	0.0 100'	Average	Median 5,400	4.9	5.1	0	0.24	15.0	9.9	0.89	7	7.8	78.8		1.3						
Dock to Meuller's			Maximum	110,000	7.0	56	0	0.40	23.5	11.3	4.0	14	7.9	81		8		1				
Dock			Minimum	43	4.1	0	0	0.27	8.5	6.6	[illegible]	3	7.7	77		0		0				
			No. of Samples	29	18	27	10	9	18	26	29	10	8	8		9	9	5		6		
	SR.35.4	500'	Average	Median 13	4.8	6.1	0	0.29	-	10.2	1.01	6	7.75	78.4		.5						
			Maximum	510	6.6	120	0	0.31	23.0	11.3	6.0	15	7.9	80		2		1				
			Minimum	0.67	3.7	6	0	0.24	8.5	6.6	0	4	7.2	76		0		0				
			No. of Samples	26	16	23	6	9	14	19	23	6	8	8		9	9	7		5		
	SR.35.4	800'	Average	Median 3.6	4.8	3.3	0	-	13.3	10.2	0.91	6	7.8	77.8		1						
			Maximum	68	6.9	50	0	-	23	11.4	4.4	15	7.9	80		1.3		1				
			Minimum	0.67	3.7	0	0	-	6.5	6.4	0	6	7.8	77		0		0				
			No. of Samples	25	16	26	7	[illegible]	16	[illegible]	[illegible]	7	8	8		9	9	8		5		

Table 19 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – ST. CLAIR RIVER (continued)

Sampling Point	Mileage Index No.	Distance from [illegible] Shore		Coliform MPN per 100 ml	Chlorides ppm	Phenols ppb	Ammonia as N ppm	Chlorine Demand ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm	Turbidity ppm	pH	Alk. ppm	Oils ppm	Threshold Odor [illegible] Raw No.	Raw Values	Chlorinated No.	Chlorinated Values	Taste	Total Solids ppm Total	Total Solids ppm Volatile
	SR.35.4	1000'	Average	Median 2.5	4.7	1.8	0.17	0.26	14.0	10.3	0.90	7	7.8	78		1						
			Maximum	840	6.9	25	0.38	0.26	23.0	11.4	4.0	10	7.9	79		2.0		1				
			Minimum	0.07	3.9	0	0	0.26	8.5	6.6	0	4	7.7	77		0		0				
			No. of Samples	35	14	28	14	1	14	19	28	6	8	8		9	8	5		3		
	SR.35.4	1000'	Average	Median 930	5.4	2.6	0	0.25	14.0	10.1	0.96	7	7.8	78.6		5						
			Maximum	9200	11.4	15	0	0.32	22.5	11.4	5.0	20	7.9	80		20		1.3				
			Minimum	36	3.0	0	0	0.10	6.5	6.3	0	4	7.8	77		0		0				
			No. of Samples	29	18	27	10	16	20	28	28	10	8	8		9	9	5		7		
	SR.35.4	3200'					Canadian	Shore														
Marysville M.Y. to Canadian Oil Co. Dock	SR.31.8	0.0 100'	Average	Median 4800	9.6	1.8	0 U.	S. 0.31	Shore 14.5	9.9	0.78	7	7.7	78.4		2.3						
			Maximum	98000	48.0	6	0.004	0.38	24.0	11.4	3.0	18	7.9	80		1.1		1				
			Minimum	40	4.0	0	0	0.24	8.5	6.4	0	4	7.6	79		0		0				
			No. of Samples	32	20	29	12	9	20	27	31	12	8	8		9	8	7		7		
	SR.31.8	700'	Average	Median 22	5.0	4.0	0	0.26	14.0	10.3	0.72	8	7.8	78.6		1						
			Maximum	3400	6.8	37	0	0.30	25.5	11.4	3.0	12	7.9	80		8		3.3				
			Minimum	4.5	4.0	0	0	0.20	7.5	6.6	0	5	7.6	77		0		0				
			No. of Samples	27	16	26	8	9	16	24	25	8	8	8		9	9	6		4		
	SR.31.8	1000'	Average	Median 4.6	5.0	2.9	International 0.005	0.23	Boundary 13.5	10.3	0.74	7	7.8	78.2		0.3						
			Maximum	1,600	6.6	50	0.08	0.31	23.6	11.6	3.6	14	7.9	80		1.1		1				
			Minimum	1	4.0	0	0	0.10	7.5	6.2	0.	6	7.6	76		0		0				
			No. of Samples	28	17	23	9	9	17	24	27	9	8	8		9	7	6		4		
	SR. 31.8	1400'	Average	Median 41	5.0	0.66	0	0.24	13.8	10.4	0.80	7	7.8	78.6		0.3						
			Maximum	1,600	6.2	7	0	0.31	23.0	11.6	4.6	14	7.9	80		2.8		1				
			Minimum	7.8	3.9	0	0	0.06	7.5	6.3	0	4.0	7.7	78		0						
			No. of Samples	26	16	24	8	9	17	22	26	8	8	8		9	9	1		5		
	SR.31.8	1900'	Average	Median 1,600	5.3	7.6	0	0.28	14.5	10.2	0.88	9	7.8	78.4		5						
			Maximum	>24,000	6.6	40	0.04	0.32	22.5	11.6	3.5	16	7.9	80		40		6.7				
			Minimum	78	4.3	0	0	0.20	7.5	6.5	0	4	7.7	78		0						
			No. of Samples	32	20	29	18	9	19	28	29	12	8	8		9	9	1		6		
	SR.31.8	3200'					Canadian	Shore														
Stag Island Middle light to Stag Island U.S. Channel	SR.29.75	0.0 100'	Average	Median 4,300	6.5	3.1	0 U.	S. 0.29	Shore 14.5	9.9	0.78	7	7.7	78.6		1						
			Maximum	>16,000	20.0	30	0.006	0.34	24.0	11.9	2.5	13	7.8	79		2		1				
			Minimum	130	4.1	0	0	0.25	9.0	6.3	0	4	7.7	78		0						
			No. of Samples	16	11	19	8	4	11	14	17	8	3	3		4	4	1		8		
	SR.29.75	700	Average	Median 150	5.3	2.2	0	0.26	13.8	10.2	0.59	7	7.9	79								
			Maximum	> 2,400	6.6	15	0	0.30	24.0	11.2	3.0	11	7.8	79		1.1		1.1				
			Minimum	2	4.1	0	0	0.20	8.0	8.6	0	4	7.7	79		0						
			No. of Samples	12	8	18	8	4	8	13	15	5	3	3		4	4	1		5		
	SR.29.75	1200'	Average	Median 4.6	5.0	2.1	0	0.22	14.5	10.3	0.56	8	7.8	78.3		0.3						
			Maximum	43	6.0	15	0	0.31	23.0	11.4	3.1	9	7.8	79		1		1				
			Minimum	1.8	4.2	0	0	0.10	8.0	8.7	0	6	7.7	78		0						
			No. of Samples	13	7	16	4	4	7	11	14	4	3	3		4	4	1		4		
	SR.29.75	1400'						International	Boundary													
	SR.29.75	1600'						West Shore	of Stag Is.													
Stag Is. Ferry Dock to Corruna Ferry Dock (Canadian Channel)	SR.30.12	0.0 100'	Average	Median 17	4.8	7.6	0	East Shore 0.26	of Stag Is. 14.5	10.4	0.64	7	7.8	78.2		1						
			Maximum	95	5.4	40	0	0.32	23.0	11.8	2.5	9	7.9	79		1		1				
			Minimum	1.8	4.1	0	0	0.20	7.5	8.7	0	5	7.6	77		0						
			No. of Samples	13	7	17	4	4	7	11	14	4	3	3		4	4	1		3		
	SR.30.12	500'	Average	Median 93	4.9	3.6	0	0.26	14.5	10.3	0.59	6	7.8	78		10						
			Maximum	1,600	6.0	30	0	0.38	23.0	11.8	2.1	8	7.9	79		40		4.7				
			Minimum	13	3.9	0	0	0.20	7.5	8.7	0	5	7.7	77		0						
			No. of Samples	15	8	19	5	4	8	14	18	5	3	3		4	4	1		5		

Table 19 —SUMMARY OF AVERAGE ANALYTICAL RESULTS— ST. CLAIR RIVER (continued)

Sampling Point	Range Index No.	Distance from [illegible]		Coliforms MPN per 100 ml	Chlorides ppm	Phenols ppb	Amm. as N ppm	Chlo. Dem. ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm	Turbidity ppm	pH	Alk. ppm	[illegible] ppm	Threshold Odor, Cold: Raw No.	Raw Range	Chlorinated No.	Chlorinated Range	Taste	Total Solids ppm: Total	Volatile
	SR.30.12	900'	Average	Median 3,400	5.6	13.0	0	0.26	15.0	10.6	1.00	8	7.8	79.3		1						
			Maximum	4,600	6.7	140	0	0.30	22.5	11.3	5	10	7.9	72		2		1				
			Minimum	220	4.6	0	0	0.20	7.5	8.6	0.14	4	7.6	70		0						
			No. of Samples	18	11	21	8	6	11	16	17	8	3	3		4	4	1		2		
	SR.30.12	1100'						Canadian Shore														
Above City of St.	SR.26.7	0.0 100'	Average	Median 3,600	6.1	21	0	U. S. Shore 0.21	17.0	9.6	0.71	7	7.85	78.5		0.3						
Clair to Moore			Maximum	34,000	13.0	240	0.008	0.28	22.5	11.4	3.4	17	7.9	79		1		1				
Municipal Dock			Minimum	270	4.5	0	0	0.20	9.0	8.1	0	4	7.8	78		0						
			No. of Samples	21	10	22	9	5	10	14	19	8	2	2		3	3	1		7		
	SR.26.7	600'	Average	Median 950	5.6	2.5	0	0.22	16.0	10.1	0.58	9	7.75	78		0.3						
			Maximum	11,000	6.9	20	0	0.31	22.5	11.2	3.0	14	7.8	78		1		1				
			Minimum	14	3.8	0	0	0.15	8.5	8.5	0	4	7.7	78		0						
			No. of Samples	17	6	20	4	3	6	9	15	4	2	2		3		1		3		
	SR.26.7	1000'						International Boundary														
	SR.26.7	1200'	Average	Median 10	5.0	5.5	0	0.19	16.0	10.5	0.38	6	7.8	78		0.3						
			Maximum	70	5.6	25	0	0.30	25.0	11.7	1.8	12	7.9	78		1		1				
			Minimum	2	4.2	0	0	0.02	8.5	8.7	0	3	7.7	78		0						
			No. of Samples	18	7	19	5	3	7	12	18	5	2	2		3	2	1		4		
	SR.26.7	1600'	Average	Median 110	5.0	4.6	0	0.26	15.5	10.0	0.86	6	7.85	78.5		0.3						
			Maximum	920	6.0	50	0	0.30	25.0	11.6	3.3	8	7.9	79		1.1		1.2				
			Minimum	3.6	4.1	0	0	0.15	6.5	8.6	0	4	7.8	78		0						
			No. of Samples	17	6	19	4	3	6	9	13	4	2	2		3	2	1		3		
	SR.26.7	1900'	Average	Median 490	5.3	9.9	0	0.26	16.5	10.1	0.76	5	7.8	78		4						
			Maximum	4,800	6.0	70	0	0.30	22.5	11.6	2.1	10	7.9	78		10		1				
			Minimum	7.8	4.0	0	0	0.20	10	8.8	0	3	7.7	78		1						
			No. of Samples	21	10	23	8	3	10	16	19	8	2	2		3	3	1		7		
	SR.26.7	2000'						Canadian Shore														
Pine River at Highway M29	SRPn 25.2		Average	(Median) 9,300	24	2.8	0.08	1.6	4.0	12.0	2.4	61	7.5	87		2						
Bridge			Maximum	460,000	60	15	0.38	2.0	16.5	14.1	6.5	509	7.8	130		4						
			Minimum	1,500	9.1	0	0	1.2	0	8.5	0.65	5	7.4	60		1						
			No. of Samples	15	16	16	16	4	16	16	16	13	16	16		15						
American Shore to	SR.24.2	0.0 100'	Average	Median 4,300	12.0	2.0	0	U.S. Shore Line	18.0	9.1	0.15	5.8										
Courtright			Maximum	7,500	16.0	8.0	0		19.5	9.4	0.44	6.6										
			Minimum	2,400	8.2	0	0		18.0	8.8	0.18	5.0										
			No. of Samples	4	4	4	4		4	4	4	4										
	SR.24.2	1100'						International Boundary														
	SR.24.2	2000'	Average	Median 930	5.7	3.7	0		17.5	9.6	0.44	[illegible]										
			Maximum	2,400	6.1	15.0	0		19.0	9.9	0.68	[illegible]										
			Minimum	430	5.4	0	0		16.5	9.2	0.32	4.0										
			No. of Samples	4	4	4	4		4	4	4	4										
	SR.24.2	2100'						Canadian Shore														
Marine City Ferry	SR.17.5	0.0 100'	Average	Median 1,700	8.6	12	0.004	U. S. Shore 0.24	19.0	9.8	[illegible]	[illegible]	7			0.5						
Dock to Sombra Ferry			Maximum	9,300	11.0	160	0.04	0.32	24.0	10.9	4	15	7.9	78		1		1				
Dock			Minimum	350	4.7	0	0	0.18	16.0	8.4	0	4				0						
			No. of Samples	28	10	23	9	2	10	16	20	9	1	1		2	2	1		7		
	SR.17.5	1200'	Average	Median 180	7.5	5.4	.0008	0.26	19.0	10.1	0.76	9				0.5						
			Maximum	24,000	10.0	60	.004	0.31	23.5	11.2	1.9	12	7.9	78		1		1				
			Minimum	11	5.8	0	0	0.20	15.0	6.5	0	5				0						
			No. of Samples	18	6	19	5	2	5	8	16	6	1	1		2	2	1		3		
	SR.17.5	1800'						International Boundary														
	SR.17.5	1900'	Average	Median 170	5.5	6.1	0.01	0.25	17.0	10.1	0.95	6				0.3						
			Maximum	8,100	5.9	35	0.08	0.26	23.0	11.3	3.0	16	7.9	79		1.1		1				
			Minimum	13	5.1	0	0	0.20	9.5	8.5	0	4				0						
			No. of Samples	19	7	20	6	2	7	11	18	6	1	1		2		1		4		

Table 19 —SUMMARY OF AVERAGE ANALYTICAL RESULTS— ST. CLAIR RIVER (continued)

Sampling Point	Mileage Index No.	Distance from [illegible]		Coliform MPN per 100 ml	Chlorides ppm	Phenols ppb	Ammonia as N ppm	Chlorine Demand ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm	Turbidity ppm	pH	Alk. ppm	Oils ppm	Threshold Odor, Cold: Raw No.	Raw Nature	Chlorinated No.	Chlorinated Nature	Taste	Total Solids ppm: Total	Volatile
	SR.17.5	2200'	Average	Median 240	5.5	4.4	.0008	0.23	17.0	10.2	0.67	7				1						
			Maximum	4,600	5.8	15	0.004	0.30	23.0	11.4	2.4	10	7.9	79		1.1		1				
			Minimum	13	4.7	0	0	0.15	9.5	8.6	0	5				0						
			No. of Samples	16	6	10	3	4	8	9	17	8	1	1		3	3	1		3		
Marine City Ferry	SR.17.5	2800'	Average	Median 430	5.1	13.8	.0009	.30	17.0	10	0.46	6				0.9						
Dock to Sombra			Maximum	> 2,400	5.8	80	.008	.30	25.0	11.5	4.0	9	7.9	78		1.1		1				
Ferry Dock			Minimum	150	3.9	0	0	.30	13.5	8.8	0	3				0						
			No. of Samples	22	10	23	9	2	10	14	20	9	1	1		8	2	1		7		
	SR.17.5	3300'					Canadian		Shore													
Belle River at Highway [illegible]	SRBe 17.5		Average	(Median) 9,300	20	2	0.14	1.3	4.5	10.4	2.1	71	7.7	150		1.5						
Bridge			Maximum	93,000	45	18	0.14	1.5	17.5	12.4	3.8	375	8.0	270		5						
			Minimum	910	6.5	0	0	1.1	0	8.0	0.88	4	7.2	84		1						
			No. of Samples	19	18	18	18	4	19	19	20	14	18	18		17						
Above Salt Dock	SR.16.8	00 100'	Average	Median 2,400	7.2	4.4	U. S. .008	0.31	Shore 18.0	9.8	0.52					1.3						
Light to Canadian			Maximum	>24,000	10.5	25	.08	0.31	24.0	10.9	1.7	15	7.8	77		8		1				
Shore (below Woodtick			Minimum	790	1.1	0	0	0.30	10	8.4	0	6				1.1						
Island)			No. of Samples	16	11	19	10	2	11	16	17	10	1	1		8	2	1		6		
	SR.16.8	900'	Average	Median 930	6.4	2.7	0.027	0.24	17.0	10.1	0.64	10				1						
			Maximum	11,000	8.2	10	0.16	0.29	27.5	11.5	2.5	18	7.8	79		1.1		1				
			Minimum	350	4.3	0	0	0.20	10.0	8.5	0	4				1						
			No. of Samples	12	7	15	8	2	7	9	12	6	1	1		8	2	1		3		
	SR.16.8	1400'	Average	Median 180	5.3	2.4	.05	0.20	17.0	10.1	0.6	8				0.9						
			Maximum	4,600	6.2	10	0.24	0.29	23.0	11.5	2	14	7.8	77		1.1		1				
			Minimum	13	4.0	0	0	0.1	10.0	8.6	0	5				0						
			No. of Samples	13	8	16	7	2	8	11	14	7	1	1		2		1		4		
	SR.16.8	1600'					International		Boundary													
	SR.16.8	1800'	Average	Median 300	5.1	22.5	.001	.24	17.0	10.2	.61	7										
			Maximum	930	5.6	280	.006	.28	23.0	11.5	2.7	10	7.8	77		1.1		1				
			Minimum	79	4.5	0	0	.20	10.0	8.6	0	4										
			No. of Samples	12	7	15	6	2	7	11	12	6	1	1		1		1		4		
	SR.16.8	2500'	Average	Median 320	4.9	15	.05	[illegible]	17.5	10.1	.74	7				1						
			Maximum	1,100	5.6	175	.10	.18	23.0	11.6	4	13	7.9	79		1		1				
			Minimum	170	4.0	0	0	.15	10.0	9.3	0	4				1						
			No. of Samples	16	11	19	10	2	11	15	15	10	1	1		2	2	1		7		
	SR.16.8	3000'					Canadian		Shore													
Robert's Landing	SR.13.7	0.0 100'	Average	Median 2,400	7.9	7.1	U. .001	.25	Shore 16.5	9.7	0.84	9										
to Port Lambton			Maximum	110,000	11.0	35	.01	.35	24.0	11.0	3	16	7.8	79		1		1			128	34
Ferry Dock			Minimum	23	6.0	0	0	.10	10.0	8.3	0	4										
			No. of Samples	28	14	27	13	3	14	20	25	14	1	1		1	1	1		8	1	1
	SR.13.7	700'	Average	Median 640	6.9	21.7	.015	[illegible]	16.9	[illegible]	.74	7										
			Maximum	15,000	9.0	400	.16	.30	24.0	11.3	4	16	7.9	79		1		1			126	36
			Minimum	79	5.2	0	0	.10	10.0	8.6	0	2				0						
			No. of Samples	24	10	24	9	3	10	12	21	10	1	1		2	2	1		4	1	1
	SR.13.7	1000'	Average	Median 170	5.6	5.1	0	.25	16.0	10.2	0.9	7				0.5						
			Maximum	11,000	8.0	25	0	.35	23.5	11.4	2	11	7.9	79		1.1		1			76	
			Minimum	0	4.9	0	0	.10	10.0	8.6	0	4				0						
			No. of Samples	26	11	25	10	3	11	15	23	11	1	1		2	2	1		5	1	
	SR.13.7	1200'					International		Boundary													
	SR.13.7	1400'	Average	Median 290	5.2	1.9	0	.25	15.0	10.3	.75	6										
			Maximum	1,100	5.8	12.0	0	.39	23.0	11.6	3.0	15	7.8	79		1		1			182	44
			Minimum	60	4.5	0	0	.10	10.0	8.6	0	2				0						
			No. of Samples	24	10	22	9	3	10	12	20	11	1	1		2	2	1		4	1	1

Table 19 — SUMMARY OF AVERAGE ANALYTICAL RESULTS — ST. CLAIR RIVER (continued)

Sampling Point	Mileage Index No.	Distance from [illegible]		Coliforms MPN per 100ml	Chlorides ppm	Phenols ppb	Ammonia as N ppm	Chlor Dem. ppm	Temp °C	D.O. ppm	BOD 5 day ppm	Turbidity ppm	pH	Alk. ppm	Oils ppm	Threshold Odor, Cold: Raw No.	Raw Odors	Chlorinated No.	Chlorinated Nature	Taste	Total Solids ppm Total	Total Solids ppm Volatile
Robert's Landing to	SR.13.7	1900'	Average	Median 880	5.1	5.5	0	.25	14.0	10.5	.60	7				0.5						
Port Lambton			Maximum	2,400	6.4	35	0	.36	23.0	11.6	3.0	11	7.8	79		1		1			142	60
Ferry Dock			Minimum	< 1.8	4.0	0	0	.20	10.0	8.9	0	4				0						
			No. of Samples	28	14	28	15	5	14	19	24	14	1	1		2	2	1		8	1	1
	SR.13.9	2100'						Canadian Shore														
							U. S. Shore (mainland)															
North Channel	SR.10.0N	00 100'	Average	Median 1,800	6.8	5.7	0	.23	14.5	9.9	.61	8	7.8	79		1						
Below Russel Island			Maximum	46,000	8.8	60	0	.30	24.0	11.1	3	15	7.8	78		1		1				
and Algonac			Minimum	130	4.8	0	0	.10	10.0	8.4	0	2	7.6	78		0						
			No. of Samples	30	15	25	15	5	15	19	22	13	2	2		3	3	1		8		
	SR.10.0N	500'	Average	Median 430	5.9	3.6	0	.17	15.5	10.2	.79	8	7.8	79								
			Maximum	4,600	8.0	60	0	.30	23.5	11.1	4	15	7.8	80		1		1				
			Minimum	45	4.5	0	0	.08	10.0	8.5	0	4	7.8	78		0						
			No. of Samples	27	12	23	10	4	12	14	20	10	2	2		4	4	2		6		
	SR.10.0N	900'	Average	Median 140	5.1	2.6	0	.22	15.5	10.3	5.5	7	7.8	78								
			Maximum	11,000	7.8	36	0	.29	23.5	11.6	2.6	12	7.8	78		1.1		1				
			Minimum	49	3.8	0	0	.10	10.0	8.7	0	4	7.8	78		0						
			No. of Samples	24	11	21	9	3	11	12	19	9	2	2		3	3	1		4		
	SR.10.0N	1400'					East Side of North Channel (U.S.) (Harsens Island)															
							U. S. Shore															
South Channel below	SR.10.0S	00 100'	Average	Median 246	5.1	5.3	0	.25	15.0	10.3	.70	8	7.8	79		0.4						
Russell Island			Maximum	2,400	6.0	30	0	.32	23.5	11.4	2.6	8	7.8	80		1		1				
			Minimum	12	4.4	0	0	.10	7.0	8.7	0	4	7.8	78		0						
			No. of Samples	24	9	18	6	4	9	12	15	6	3	3		4	4	1		3		
	SR.10.0S	500'	Average	Median 240	5.1	7.6	0	.24	14.0	10.3	.8	7	7.8	78		0.5						
			Maximum	> 2,400	6.0	85	0	.28	23.5	11.4	2.6	9	7.9	79		1		1				
			Minimum	9.3	4.6	0	0	.10	10.0	8.6	0	5	7.8	78		0						
			No. of Samples	25	10	19	7	4	10	14	16	7	3	3		4	4	1		4		
	SR.10.0S	600'					International Boundary															
	SR.10.0S	900'	Average	Median 430	4.7	24	.02	.23	14.0	10.2	.62	8	7.8	79		0.5						
			Maximum	4,600	5.5	410	.16	.31	23.5	11.5	2.4	[illegible]	7.9	79		1		1				
			Minimum	70	2.6	0	0	.05	7.0	8.7	0	4	7.8	78		0						
			No. of Samples	27	12	22	10	4	12	14	20	10	3	3		4	4	1		7		
	SR.10.0S	1500'					Canadian Shore West Side (Walpole Island)															
		00					U. S. Shore															
South Channel below	SR.6.0S	100'	Average	Median 240	5.2	10	.05	.19	17.5	10.4	.58	5				0.5						
Tashmoo Park			Maximum	4,600	6.0	50	.14	.29	23.5	12.5	1.5	9	7.8	79		1		1			122	44
			Minimum	130	4.0	0	0	.10	10.0	8.6	.20	2				0						
			No. of Samples	6	5	7	3	3	5	6	6	5	1	1		2	2	1		2	1	1
	SR.6.0S	400'	Average	Median 240	5.2	4.5	0	.23	17.5	10.3	.46	5				0.5						
			Maximum	4,600	6.6	13	0	.29	23.5	12.1	1.30	6	7.8	79		1		1			124	60
			Minimum	130	4.4	0	0	.10	10.0	8.6	.10	4				0						
			No. of Samples	7	6	6	5	3	6	7	7	6	1	1		2	2	1		3	1	1
	SR.6.0S	700'	Average	Median 340	5.0	22	.0012	.20	17.5	10.0	.55	6										
			Maximum	920	5.8	100	.01	.29	23.5	12.3	1.9	12	7.8	79		1		1			150	50
			Minimum	140	3.3	0	0	.10	10.0	8.7	.16	4				0						
			No. of Samples	10	9	11	6	3	9	10	10	9	1	1		2	2	1		6	1	1
	SR.6.0S	900'					International Boundary															
	SR.6.0S	2300'					Canadian Shore															
								U. S. Shore														
South Channel Lt.	SR.5.0S	00 100'	Average	Median 490	5.0	2.5	.003	.29	18.0	10.3	.32	7										
No.27 to Canada			Maximum	4,600	6.0	5	.01	.29	23.0	11.3	.51	10	7.8	79		0						
Club			Minimum	170	4.8	0	0	.29	10.0	8.6	.12	5				0						
			No. of Samples	4	4	4	3	1	4	4	4	3	1	1		2	2			1		
	SR.5.0S	500'	Average	Median 430	5.1	34	0	.29	16.0	10.2	.45	7										
			Maximum	> 2,400	6.0	160	0	.29	23.5	11.3	.55	12	7.8	78		0						
			Minimum	210	3.9	0	0	.29	10.0	8.7	.27	4										
			No. of Samples	5	5	5	4	1	5	5	5	4	1	1		1	1			2		
	SR.5.0S	900'					International Boundary															

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Table 19 —SUMMARY OF AVERAGE ANALYTICAL RESULTS— ST. CLAIR RIVER (continued)

Sampling Point	Mileage Index No.	Distance from Shore		Coliform org. per 100 ml	Chlorides ppm	Phenol ppb	Ammonia as N ppm	Chlor. Dem. ppm	Temp. °C	D.O. ppm	BOD 5 day ppm	Turbidity ppm	pH	Alk. ppm	Oils ppm	Threshold Odor, Cold				Taste	Total Solids ppm	
																Raw		Chlorinated				
																No.	Rating	No.	Rating		Type	[illegible]
	SR.2.6S	900'	Average	Median 260	4.4	8.5	0	.08	[illegible]	9.9	0.28	6										
			Maximum	2,400	6.0	18	0	.08	26.0	11.3	0.7	8	7.8	79		0						
			Minimum	260	1.6	0	0	.02	10.0	8.7	0.20	4										
			No. of Samples	8	8	8	7	1	8	8	8	7	1	1		1	1			5		
	SR.2.6S	1,150'					Canadian Shore															
		00'						U. S. Shore														
South Channel at Lt. No. 17 below Forster	SR.2.8S	150'	Average	Median 240	5.0	9	0		[illegible]	10.5	.37	11										
			Maximum	930	6.2	30	0		14.0	10.8	0.30	22										
			Minimum	210	4.0	0	0		11.0	10.1	0.13	5										
			No. of Samples	[illegible]	7	7	7		5	7	7	7								3		
	SR.2.8S	300'	Average																			
			Maximum	2,400	3.9	0	0		14.5	10.4	0.38	8										
			Minimum																			
			No. of Samples	1	1	1	1		1	1	1	1										
	SR.2.8S	500	Average	Median 430	5.5	4	0		[illegible]	10.6	.43	12										
			Maximum	930	6.9	10	0		14.5	10.8	0.52	16										
			Minimum	210	4.6	0	0		14.5	10.5	0.29	7										
			No. of Samples	3	3	3	3		1	3	3	3										
	SR.2.8S	600'					International Boundary															
	SR.2.8S	600'	Average	Median 750	4.9	6	0		[illegible]	10.4	0.37	7										
			Maximum	930	5.1	20	0		15.0	10.5	0.52	11										
			Minimum	230	4.8	0	0		11.0	10.3	0.23	5										
			No. of Samples	4	5	5	5		5	5	5	5								1		
	SR.2.8S	700'	Average																			
			Maximum	430	5.1	0	0		14.0	10.5	0.64	8										
			Minimum																			
			No. of Samples	1	1	1	1		1	1	1	1										
	SR.2.8S	1000'	Average																			
			Maximum	430	5.0	2	0			10.6	0.42	16										
			Minimum																			
			No. of Samples	1	1	1	1			1	1	1										
	SR.2.8S	1150	Average	Median 430	4.8	7	0		13.1	10.4	0.38	6										
			Maximum	930	5.0	28	0		15.0	10.5	0.68	10										
			Minimum	230	4.0	0	0		11.0	10.3	0.22	3										
			No. of Samples	5	5	5	5		5	5	5	5								3		
	SR.2.8S	1300					Canadian Shore															
		00'					U. S. Shore															
North Channel at Pearl Beach	SR.6.7N	100'	Average	Median 930	5.8	18.6	.009	.20	[illegible]	9.9	.32	7				0.5						
			Maximum	11,000	7.8	160	.01	.29	24.0	11.1	.62	8	7.9	79		1		1				
			Minimum	130	4.1	0	0	.10	10.0	8.5	0	5				0						
			No. of Samples	14	12	15	11	2	12	13	13	11	1	1		2	2	1		8		
	SR.6.7N	500'	Average	Median 1,100	5.9	9.4	0	.19	[illegible]	10.1	.46	7										
			Maximum	24,000	7.8	35	0	.28	24.0	11.1	2.1	8	7.9	79		1		1				
			Minimum	49	5.2	0	0	.10	10.0	8.5	0	5				0						
			No. of Samples	11	9	12	8	2	9	10	11	8	1	1		2	2	1		5		
	SR.6.7N	1100'	Average	Median 1,300	6.2	5.1	0	.19	[illegible]	10.1	.31	6										
			Maximum	> 24,000	7.0	56	0	.28	23.5	11.1	.56	8	7.8	79		1		1				
			Minimum	430	4.9	0	0	.10	10.0	8.5	0	4				0						
			No. of Samples	10	8	11	7	2	8	10	9	6	1	1		2	2	1				
	SR.6.7N	1400'					East Shore (U.S.) (Dickinson Island)															
		00'					U. S. Shore (Dickinson Island)															
Middle Channel below North Channel at Pearl Beach	SR.6.7N	400'	Average	Median [illegible]	5.6	3.6	0	.19	[illegible]	9.9	.30	7										
			Maximum	4,600	7.1	48	0	.28	24.0	11.2	1.0	9	7.8	79		1		1				
			Minimum	150	4.8	0	0	.10	10.0	8.4	.13	4				0						
			No. of Samples	15	13	16	12	8	13	14	1[illegible]	12	1	1		2	2	1		9		
	SR.6.7N	800'					U. S. Shore (Harsens Island)															

Table 19 — SUMMARY OF AVERAGE ANALYTICAL RESULTS — ST. CLAIR RIVER (continued)

Sampling Point	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Temp. °C	D.O. ppm	[illegible]	[illegible]	pH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Middle Channel	SD-[illegible]	100'	Average	[illegible]	6.8	14	0	-	10.0	10.8	.27	7										
above Big [illegible]			Maximum	11,000	6.8	80	0	-	16.0	10.4	0.30	8										
[illegible]			Minimum	230	6.8	0	0	-	11.0	10.8	0.18	6										
			No. of Samples	4	4	4	4		4	4	5	4								8		
	SD-[illegible]	200'	Average																			
			Maximum	2,400	6.8	0	0		10.0	10.4	0.30	7										
			Minimum																			
			No. of Samples	1	1	1	1		1	1	1	1										
	SD-[illegible]	300'	Average																			
			Maximum	2,400	6.8	0	0		14.0	10.4	0.40	7										
			Minimum																			
			No. of Samples	1	1	1	1		1	1	1	1										
	SD-[illegible]	400'	Average	Median 930	6.8	4	0		10.0	10.4	0.33	7										
			Maximum	2,400	6.8	80	0		10.0	10.8	0.38	8										
			Minimum	930	6.8	0	0		11.0	10.8	0.30	6										
			No. of Samples	4	4	4	4		4	4	4	4								8		
	SD-[illegible]	700'	Average																			
			Maximum	4,600	6.4	0	0		14.0	10.8	0.44	8										
			Minimum																			
			No. of Samples	1	1	1	1		1	1	1	1										
	SD-[illegible]	1100'	Average	Median 930	6.8	0	0		13.0	10.8	0.38	6										
			Maximum	11,000	6.8	0	0		18.0	10.8	0.40	8										
			Minimum	230	6.0	0	0		11.0	10.8	0.24	4										
			No. of Samples	4	4	4	4		4	4	2	4								2		
	SD-[illegible]	1200'																				
North Channel Above	SD-4.[illegible]	0.0 400'	Average			[illegible] ISLAND SIDE Mainland Side [illegible] miles West ? [illegible] Beach.																
[illegible] & [illegible] Road.			Maximum	3400	6.5	0	0		15.0	10.4	0.48	7										
			Minimum																			
			No. of Samples																			
	SD-4.[illegible]	500'	Average	Median 2300	6.8	12.	0		14.0	10.2	0.38	7										
			Maximum	9,300	6.9	3	0		17.0	10.4	0.41	8										
			Minimum	750	6.9	0	0		12.0	10.8	0.31	5										
			No. of Samples	4	4	4	4		4	4	4	4								1		
	SD-4.[illegible]	600'	Average																			
			Maximum	750	6.8	0	0		14.5	10.4	0.50	7										
			Minimum																			
			No. of Samples	1	1	1	1		1	1	1	1										
	SD-4.[illegible]	800'	Average	Median 2300	6.4	24	0		14.0	10.3	0.35	6										
			Maximum	24,000	7.0	120	0		18.0	10.4	0.40	8										
			Minimum	230	6.2	0	0		12.0	10.1	0.24	5										
			No. of Samples	5	5	5	5		5	3	5	5								1		
	SD-4.[illegible]	1000'	Average	Median 930	6.9	0	0		13.5	10.5	0.40	6										
			Maximum	2400	6.8	0	0		15.5	10.9	0.44	8										
			Minimum	430	6.1	0	0		12.0	10.2	0.34	4										
			No. of Samples	4	4	4	4		4	4	4	4								1		

Lake St. Clair

The intensity and distribution of pollution in Lake St. Clair are influenced by the division of flows through the St. Clair Flats, the direction of winds, the lake currents, the intermittent discharge of combined sewer overflows, and the action of natural purification agencies, although it is difficult to separate the influence of one factor from another.

Table 20 is a summary of the analytical results for Lake St. Clair samples. The coliform results indicate the water to be of good quality in the lake except for localized areas. Highest median values were found at the outlet from Anchor Bay and at the mouths of the Chenal Ecarte and Thames River. Definite pollution paths are indicated by the coliform results.

The distribution of coliform concentrations is shown in figure 6. It will be seen that, except at the mouths of the Chenal Ecarte and Thames River, the eastern portion of the lake is relatively free from pollution. The polluted waters from these two tributaries are lost within a distance of 1 to 2 miles into the lake. The main flow into the eastern section of the lake is through the South Channel. It carries 30 percent of the St. Clair River flow and comes from the less polluted middle section of the stream. The Chenal Ecarte and other tributaries on the Canadian side, carrying about 12.5 percent of the total St. Clair River flow, come from the more heavily polluted shore zone.

On the basis of the bacteriological results the bulk of the pollution entering Lake St. Clair is discharged into Anchor Bay and flows southward. There appears to be a definite line of demarcation between the pollution travelling from the North Channel and that from the Clinton River. The pollution coming from the North and Middle Channels moves as a mass or "front" and tends to flow south-southwest, becoming diffused and diluted as it moves into the lake. This front reaches the main ship channel (range I-IV-VI) about due east of Gaukler Point. In this area the pollution may follow one, or all, of three courses. A part of the front appears to split off and veer southeasterly into the larger portion of the lake on the Canadian side of the boundary. A portion seems to continue in a south by southwest direction into the Detroit River. A small portion probably splits away and veers off toward the United States shore below Gaukler Point.

The pollution from the Clinton River is apparently forced close to the west shore and follows the shore line south, around Point Huron and into the small bay to the west of Point Huron. From there the pollution tends to follow the shore line or to take a more direct course into the Detroit River.

Float studies and wind current data tend to confirm these possibilities of coliform distribution. The prevailing winds on days of sampling varied between a west-southwest and a south-southwest direction. The larger portion of the St. Clair River flow, amounting to 57.5 percent of the total, or an average of about 100,000 c.f.s., coming out of Anchor Bay in a front meets some resistance about due east of Gaukler Point and is dissipated in the west end of the lake. The winds coming from the southwest might form such resistance and might be in part responsible for the dissipation of this large flow. The winds blowing against the current would then cause a veering in different directions. Float studies in this area showed the existence of currents turning both clockwise and counter-clockwise from the flow in the ship channel.

A review of the results in table 20 reveals considerable variation between the median and maximum coliform values at the various sampling stations. Since the intensity and distribution of pollution at any one location are subjected to the many factors already mentioned these variations are not surprising. The median value is not necessarily indicative of these wide fluctuations. It is the peak or worst conditions which present a hazard to water purufication plants and to bathing beaches.

Figure 7 graphically portrays the distribution of the maximum coliform results in Lake St. Clair, as well as the average wind direction at each point on the date of the maximum occurrence. The chart indicates conditions which did occur, and which may be repeated. These conditions are especially significant in the western portion of the lake which serves as a source of water supply for Mt. Clemens, Highland Park, and Grosse Pointe Farms.

The maximum coliform results at the outlet from Anchor Bay further emphasize that there is a line of demarcation between the pollution from the Clinton River and that from the North Channel. The paths of travel above Gaukler Point are similar to those shown by the median values. Winds from the northeast or southeast quadrants caused high coliform concentrations along the United States shore from Anchor Bay to Gaukler Point. Under west-southwest winds the pollution hugged the United States shore between Gaukler Point and Windmill Point. Pollution coming through the North and Middle Channels seems to have a tendency to veer southeast across the ship channel and be dissipated in Canadian waters by winds from the southwest quadrant.

As would be expected, winds from the southwest and southeast quadrants caused high bacterial concentrations at the mouth of the Chenal Ecarte and other tributaries discharging along the north shore of the lake. Likewise, winds from the northwest and northeast quadrants built up concentrations at the mouths of the Thames and Belle Rivers, and along the south shore of the lake.

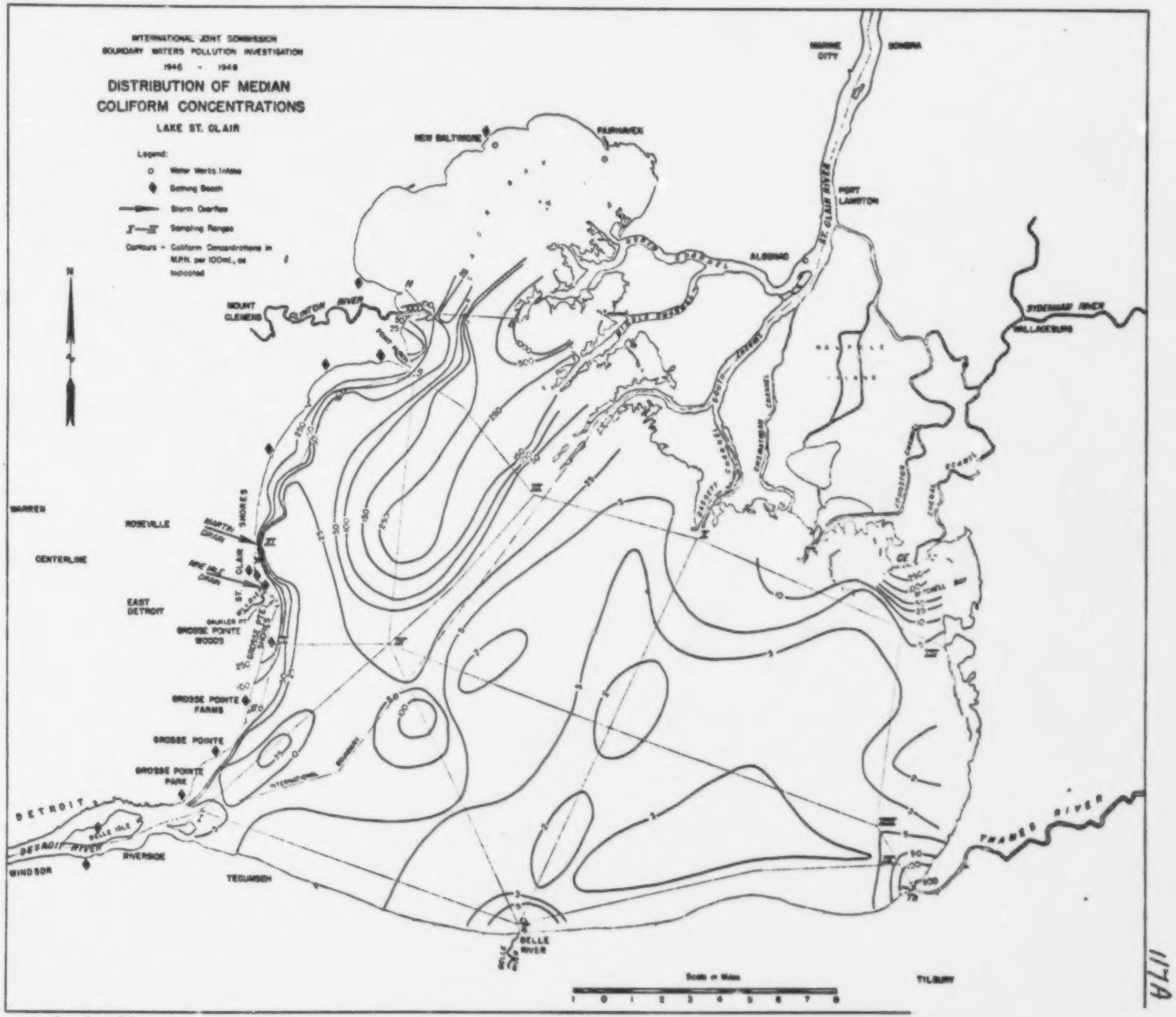
The locations of maximum M.P.N. coliform values are shown in table 20. At both the mouth of the Clinton River and at Point Huron the maximum values were 24,000 per 100 ml. From Point Huron to Windmill Point the maximum value was just under 5,000. These high concentrations can probably be attributed to the Clinton River discharge and to the various combined sewer overflows from Macomb and Wayne Counties, especially Nine Mile and Martin Drains. On the Canadian side, the highest M.P.N. value was 11,000 and was found at the mouth of the Thames River. The next highest value, 2,400 per 100 ml., was at the mouth of the Chenal Ecarte.

Maximum and average phenol results are presented in figure 8. Average values are generally below 10 p.p.b. Results on range Cl-E, across the mouth of Anchor Bay, again show a line of demarcation between the flow coming from the St. Clair River and that coming from the Clinton River. Averages varied from 8.2 p.p.b. at the mouth of the Clinton River to 2.7 at the middle of the range and up to 12 p.p.b. at the mouth of the North Channel. As would be expected, the behavior of phenol distribution in the lake followed a pattern similar to that for coliforms, since both are carried by the same water vehicle.

Analytical results for samples taken in Canadian waters showed very low average phenol concentrations. Highest values were found in the vicinity of Bassett Channel, and along the south shore of the lake near the mouths of the Thames and Belle Rivers. Maximum phenol values in the Canadian waters are generally lower than those found in the United States waters.

Oxygen results do not indicate any noticeable depletion in the lake waters. The dissolved oxygen content averaged 8 to 10 p.p.m. while minimum values were, in practically all instances, over 6 or 7 p.p.m. Biochemical oxygen demand generally averaged less than 1 p.p.m., with maximum values of up to 3 p.p.m.

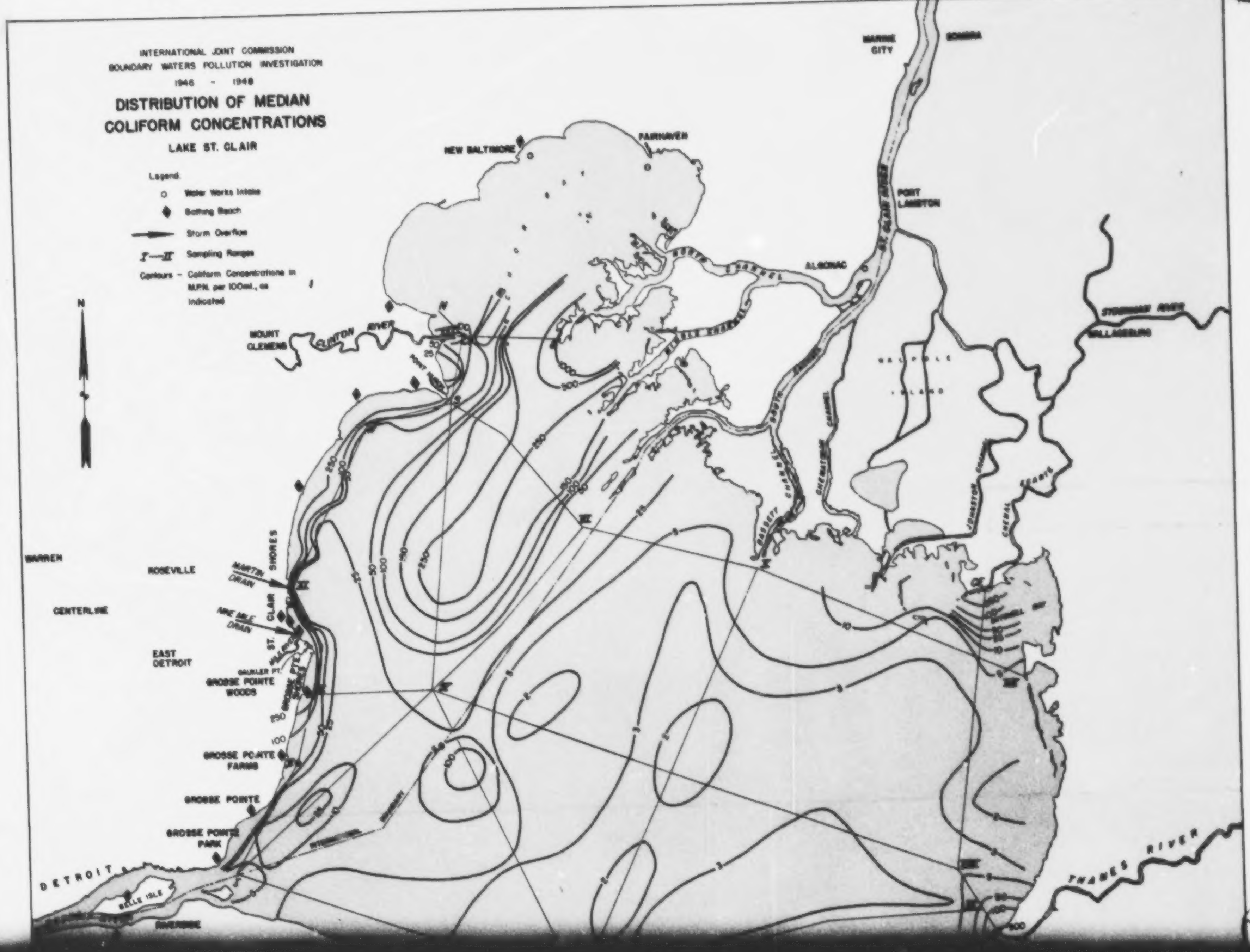
Turbidity results were highest in the United States waters and at the mouths of the larger tributaries, with values reaching up to 140 p.p.m. In the central portion of the lake results were generally under 10 or 15 p.p.m. Other analytical results showed less significant effects.


INTERNATIONAL JOINT COMMISSION
BOUNDARY WATERS POLLUTION INVESTIGATION
1946 - 1948
DISTRIBUTION OF MEDIAN
COLIFORM CONCENTRATIONS
LAKE ST. CLAIR
Legend:
Water Works Intake
Bathing Beach
Storm Overflow
I—II Sampling Ranges
Contours - Coliform Concentrations in M.P.N. per 100ml., as indicated
N
MARINE CITY
SOMBRA
NEW BALTIMORE
FAIRHAVEN
PORT LAMBTON
ST. CLAIR RIVER
ALGONAC
SYDENHAM RIVER
WALLACEBURG
MOUNT CLEMENS
CLINTON RIVER
WARREN
ROSEVILLE
CENTERLINE
ST. CLAIR SHORES
EAST DETROIT
GROSSE POINTE WOODS
GROSSE POINTE SHORES
GROSSE POINTE FARMS
GROSSE POINTE
GROSSE POINTE PARK
DETROIT
DETROIT RIVER
BELLE ISLE
WINDSOR
RIVERSIDE
TECUMSEH
BELLE RIVER
THAMES RIVER
MITCHELL BAY
TILBURY
INTERNATIONAL BOUNDARY
Scale in Miles
1 0 1 2 3 4 5 6 7 8

Litho U S Lake Survey 1949

Figure 6

A

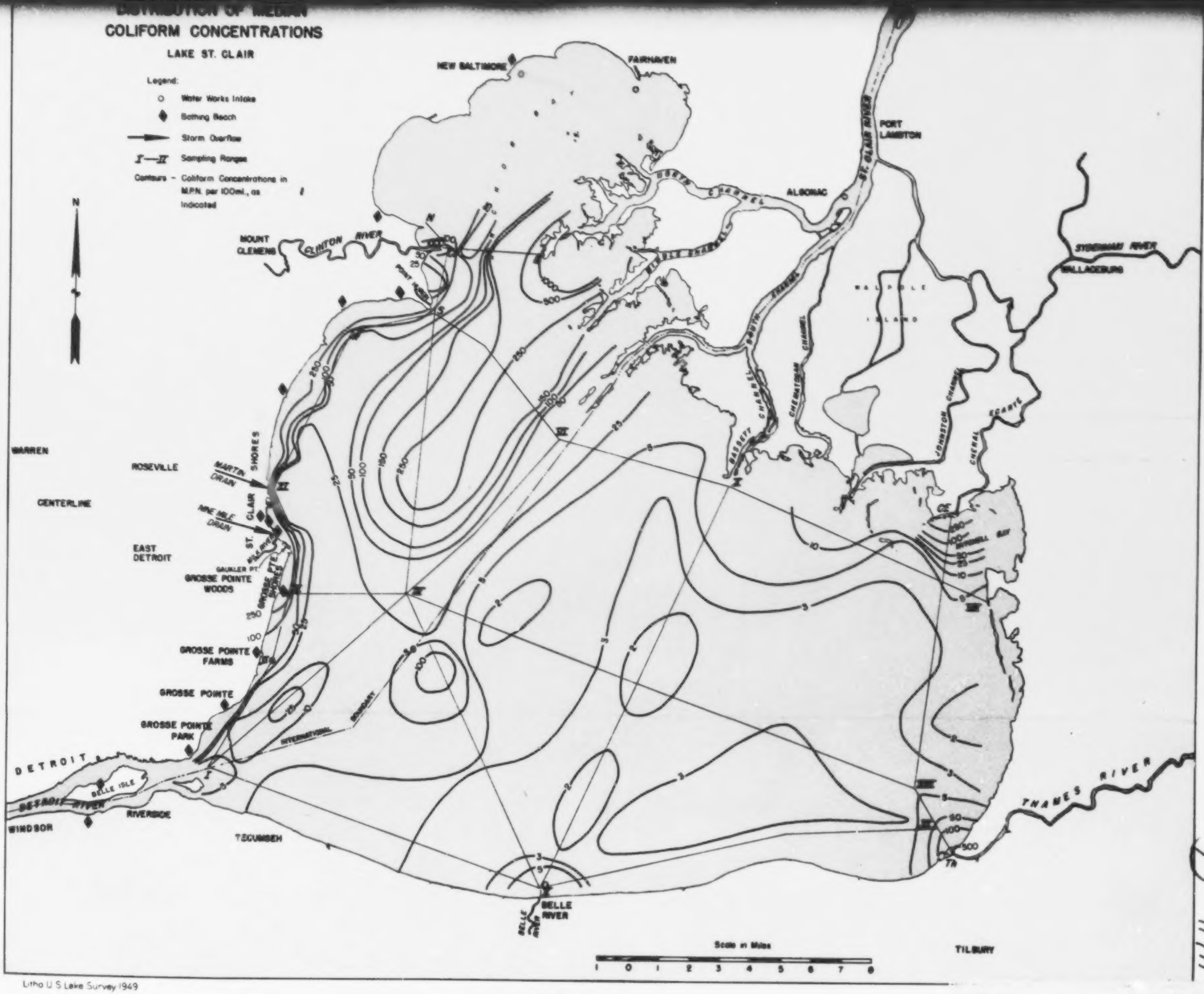


INTERNATIONAL JOINT COMMISSION
BOUNDARY WATERS POLLUTION INVESTIGATION
1946 - 1948

DISTRIBUTION OF MEDIAN COLIFORM CONCENTRATIONS

LAKE ST. CLAIR

Legend.
○ Water Works Intake
◆ Bathing Beach
Storm Overflow
I—II Sampling Ranges
Contours - Coliform Concentrations in M.P.N. per 100ml., as Indicated
N
MARINE CITY
SOMBRA
PORT LAMBTON
ST. CLAIR RIVER
ALGONAC
NORTH CHANNEL
MIDDLE CHANNEL
SOUTH CHANNEL
BASSETT CHANNEL
CHENAL ECARTE
JOHNSTON CHANNEL
WALPOLE ISLAND
SYDENHAM RIVER
WALLACEBURG
FAIRHAVEN
NEW BALTIMORE
MOUNT CLEMENS
CLINTON RIVER
WARREN
ROSEVILLE
CENTERLINE
EAST DETROIT
MARTIN DRAIN
ST. CLAIR SHORES
GAULKER PT.
GROSSE POINTE WOODS
GROSSE POINTE FARMS
GROSSE POINTE
GROSSE POINTE PARK
DETROIT
BELLE ISLE
DETROIT RIVER
RIVERSIDE
THAMES RIVER
INTERNATIONAL BOUNDARY
500
250
150
100
50
25
10
5
3
2


DISTRIBUTION OF MEDIAN
COLIFORM CONCENTRATIONS
LAKE ST. CLAIR
Legend:
○ Water Works Intake
◆ Bathing Beach
Storm Overflow
I—II Sampling Ranges
Contours – Coliform Concentrations in M.P.N. per 100ml., as Indicated
N
NEW BALTIMORE
FAIRHAVEN
PORT LAMBTON
ALGONAC
ST. CLAIR RIVER
NORTH CHANNEL
MIDDLE CHANNEL
SOUTH CHANNEL
BASSETT CHANNEL
CHEMATOGAN CHANNEL
JOHNSTON CHANNEL
CHENAL ECARTE
WALPOLE ISLAND
SYDENHAM RIVER
WALLACEBURG
MOUNT CLEMENS
CLINTON RIVER
POINT HURON
MITCHELL BAY
WARREN
ROSEVILLE
CENTERLINE
EAST DETROIT
ST. CLAIR SHORES
MARTIN DRAIN
NINE MILE DRAIN
GAULKER PT.
GROSSE POINTE WOODS
GROSSE POINTE SHORES
GROSSE POINTE FARMS
GROSSE POINTE
GROSSE POINTE PARK
DETROIT
BELLE ISLE
DETROIT RIVER
WINDSOR
RIVERSIDE
TECUMSEH
INTERNATIONAL BOUNDARY
BELLE RIVER
THAMES RIVER
TILBURY
Scale in Miles
1 0 1 2 3 4 5 6 7 8
500
250
150
100
50
25
10
5
3
2

Litho U.S. Lake Survey 1949

Figure 6

(Follows page 118)

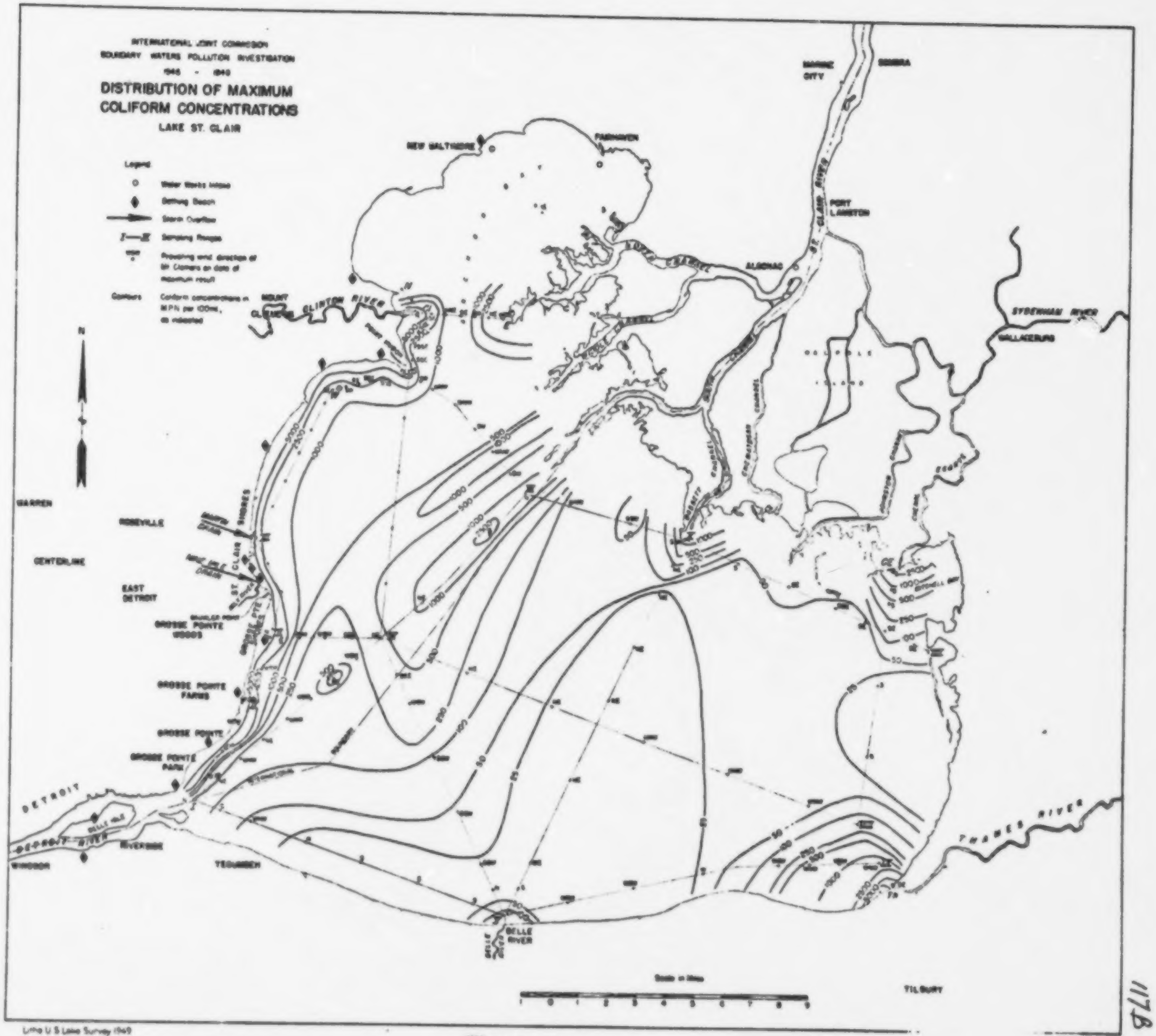

INTERNATIONAL JOINT COMMISSION
BOUNDARY WATERS POLLUTION INVESTIGATION
1946 - 1949
DISTRIBUTION OF MAXIMUM
COLIFORM CONCENTRATIONS
LAKE ST. CLAIR
Legend
Water Works Intake
Bathing Beach
Storm Overflow
Sampling Ranges
Prevailing wind direction at St. Clemens on date of maximum result
Contours
Coliform concentrations in MPN per 100ml, as indicated
N
MARINE CITY
SOMBRA
NEW BALTIMORE
FAIRHAVEN
PORT LAMBTON
ALGONAC
ST. CLAIR RIVER
SYDENHAM RIVER
WALLACEBURG
MOUNT CLEMENS
CLINTON RIVER
WARREN
ROSEVILLE
CENTERLINE
EAST DETROIT
ST. CLAIR SHORES
GROSSE POINTE WOODS
GROSSE POINTE FARMS
GROSSE POINTE
GROSSE POINTE PARK
DETROIT
DETROIT RIVER
BELLE ISLE
WINDSOR
RIVERSIDE
TECUMSEH
BELLE RIVER
THAMES RIVER
TILBURY
Scale in Miles
1 0 1 2 3 4 5 6 7 8 9
Litho U.S. Lake Survey 1949

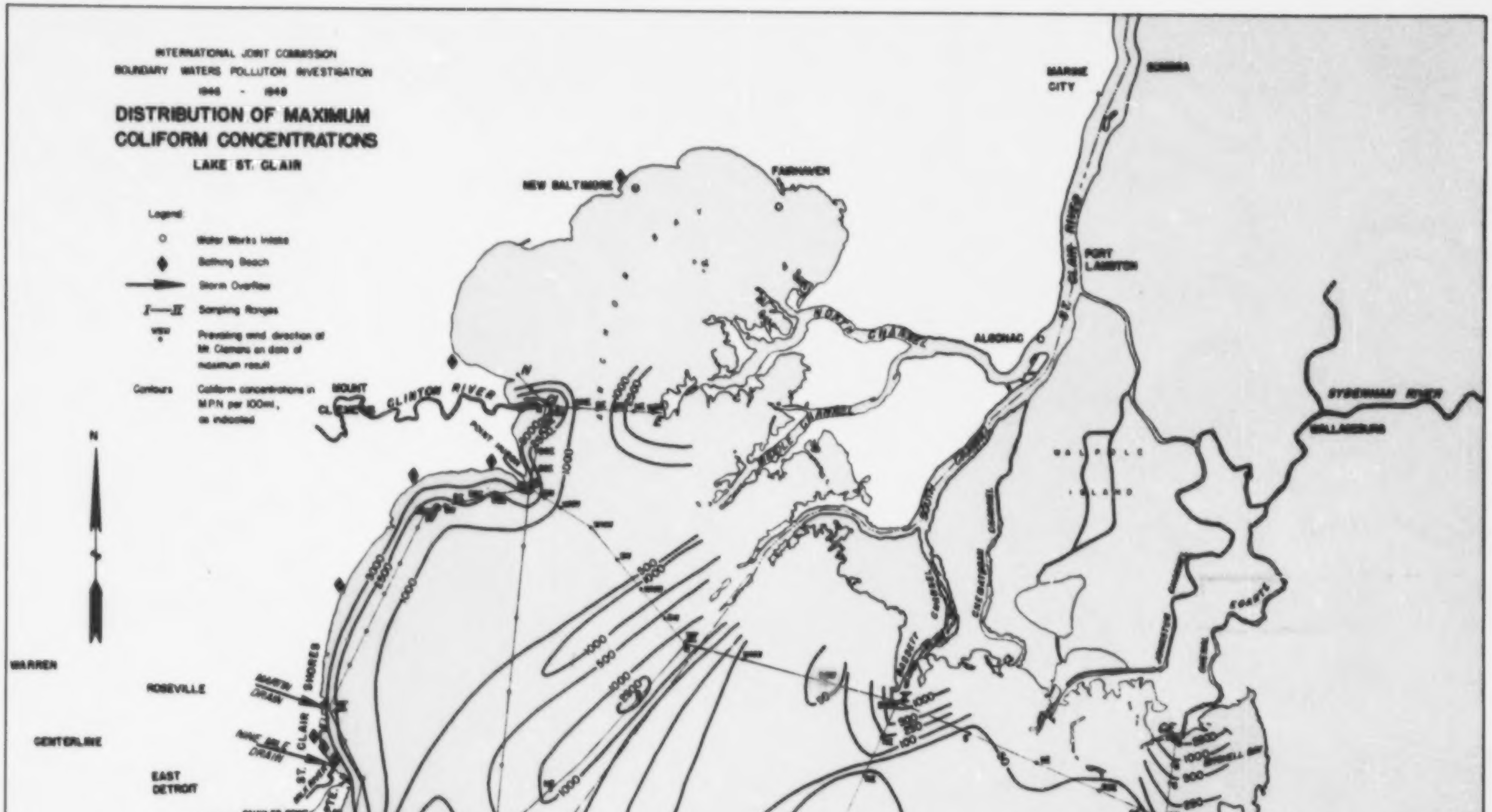
Figure 7

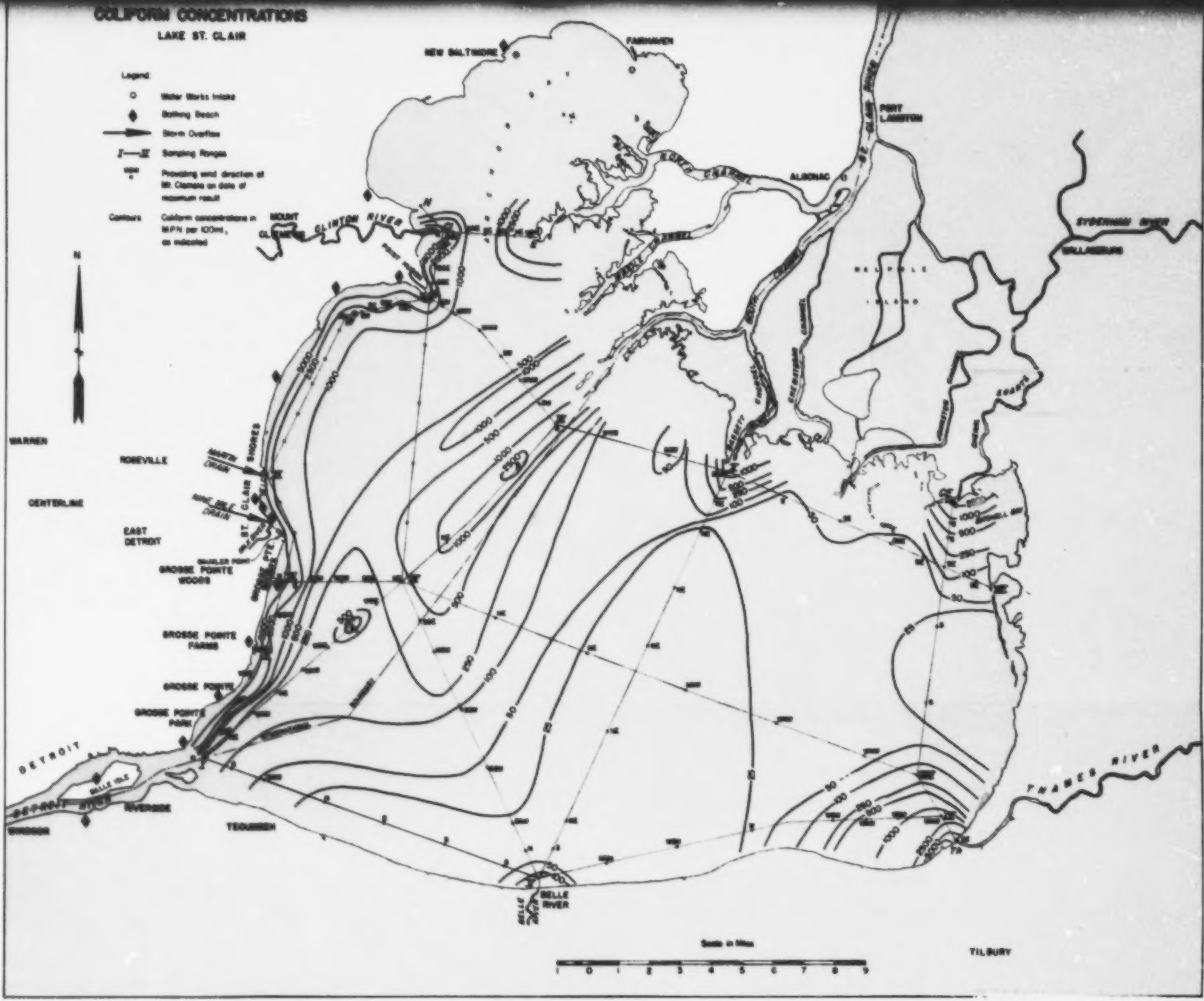
A

INTERNATIONAL JOINT COMMISSION
BOUNDARY WATERS POLLUTION INVESTIGATION
1946 - 1948

DISTRIBUTION OF MAXIMUM COLIFORM CONCENTRATIONS

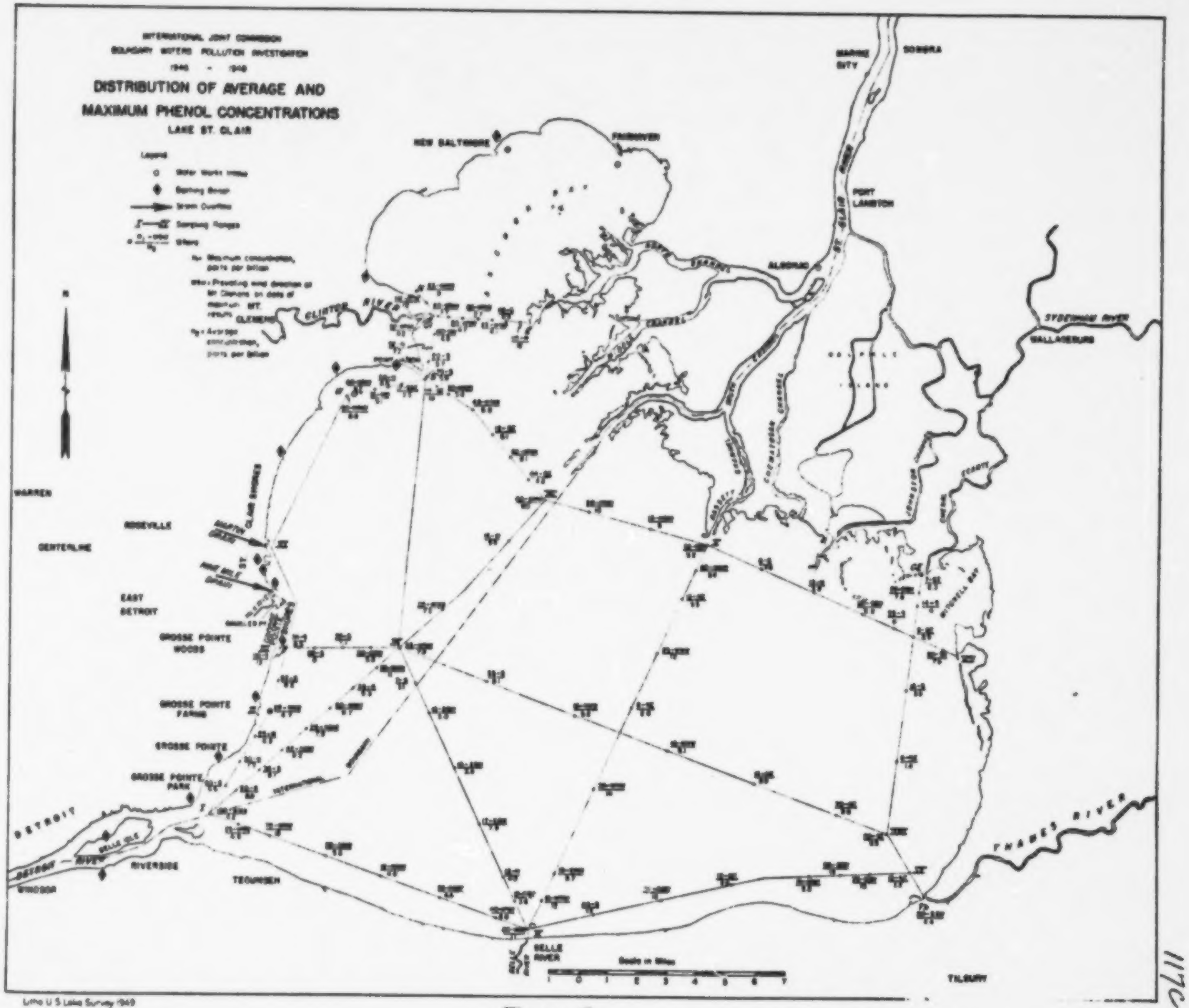
LAKE ST. CLAIR


Legend:
○ Water Works Intake
◆ Bathing Beach
→ Storm Overflow
I—II Sampling Ranges
Prevailing wind direction at Mt. Clemens on date of maximum result
Contours Coliform concentrations in MPN per 100ml, as indicated
N
MARINE CITY
SOMBRA
PORT LAMBTON
ALGONAC
ST. CLAIR RIVER
NORTH CHANNEL
MIDDLE CHANNEL
SOUTH CHANNEL
BASSETT CHANNEL
CHENAL ECARTE
WALPOLE ISLAND
SYDENHAM RIVER
WALLACEBURG
NEW BALTIMORE
FAIRHAVEN
MOUNT CLEMENS
CLINTON RIVER
WARREN
ROSEVILLE
CENTERLINE
EAST DETROIT
ST. CLAIR SHORES
MARTIN DRAIN
NINE MILE DRAIN
GROSSE PTE. SHORES
GROSSE POINTE WOODS
GROSSE POINTE FARMS
GROSSE POINTE
GROSSE POINTE PARK
DETROIT
BELLE ISLE
MITCHELL BAY
THAMES RIVER
3000
2000
1000
500
250
100
50
25


COLIFORM CONCENTRATIONS
LAKE ST. CLAIR
Legend
Water Works Intake
Bathing Beach
Storm Overflow
I—II Sampling Ranges
Prevailing wind direction at Mt. Clemens on date of maximum result
Contours Coliform concentrations in MPN per 100ml, as indicated
N
NEW BALTIMORE
FAIRHAVEN
PORT LAMBTON
ALGONAC
ST. CLAIR RIVER
NORTH CHANNEL
MIDDLE CHANNEL
CLINTON RIVER
MOUNT CLEMENS
WALPOLE ISLAND
SYDENHAM RIVER
WALLACEBURG
WARREN
ROSEVILLE
CENTERLINE
EAST DETROIT
ST. CLAIR SHORES
GROSSE POINTE WOODS
GROSSE POINTE FARMS
GROSSE POINTE
GROSSE POINTE PARK
DETROIT
BELLE ISLE
DETROIT RIVER
RIVERSIDE
WINDSOR
TECUMSEH
BELLE RIVER
THAMES RIVER
TILBURY
Scale in Miles
1 0 1 2 3 4 5 6 7 8 9
5000
2500
1000
500
250
100
50
25

Litho U.S. Lake Survey 1949

Figure 7

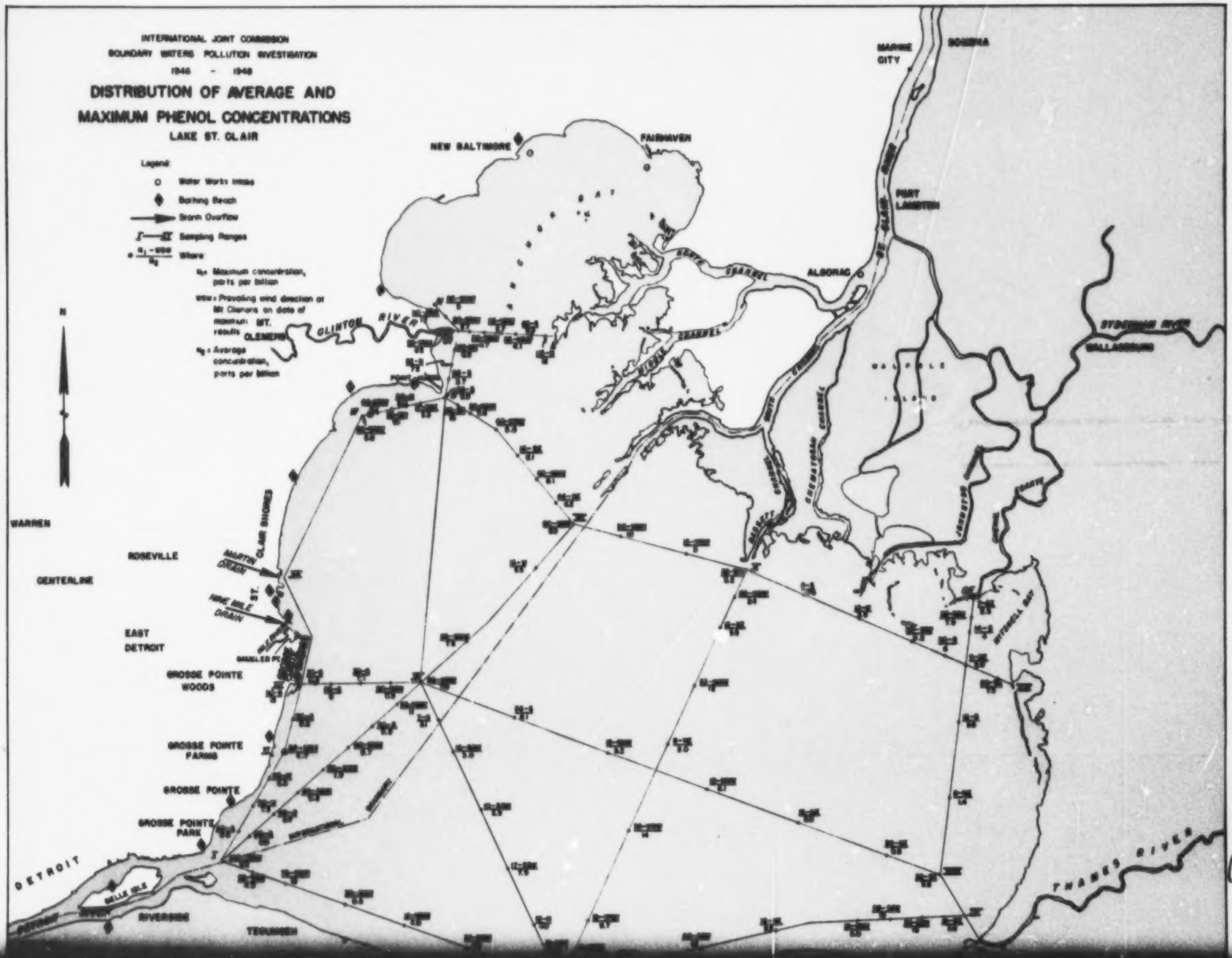

INTERNATIONAL JOINT COMMISSION
BOUNDARY WATERS POLLUTION INVESTIGATION
1946 - 1949
DISTRIBUTION OF AVERAGE AND
MAXIMUM PHENOL CONCENTRATIONS
LAKE ST. CLAIR
Legend
Water Works Intake
Bathing Beach
Storm Outflow
Sampling Ranges
Mx = Maximum concentration, parts per billion
Wd = Prevailing wind direction at Mt Clemens on date of maximum result
Ag = Average concentration, parts per billion
N
MARINE CITY
SOMBRA
NEW BALTIMORE
FAIRHAVEN
PORT LAMBTON
ALGONAC
ST. CLAIR RIVER
SYDENHAM RIVER
WALLACEBURG
MT. CLEMENS
CLINTON RIVER
WARREN
ROSEVILLE
CENTERLINE
ST. CLAIR SHORES
EAST DETROIT
GROSSE POINTE WOODS
GROSSE POINTE FARMS
GROSSE POINTE
GROSSE POINTE PARK
DETROIT
DETROIT RIVER
BELLE ISLE
WINDSOR
RIVERSIDE
TECUMSEH
BELLE RIVER
MITCHELL BAY
THAMES RIVER
TILBURY
Scale in Miles
1 0 1 2 3 4 5 6 7

Litho U S Lake Survey 1949

Figure 8

117C

A



INTERNATIONAL JOINT COMMISSION
BOUNDARY WATERS POLLUTION INVESTIGATION
1946 - 1948

DISTRIBUTION OF AVERAGE AND MAXIMUM PHENOL CONCENTRATIONS
LAKE ST. CLAIR

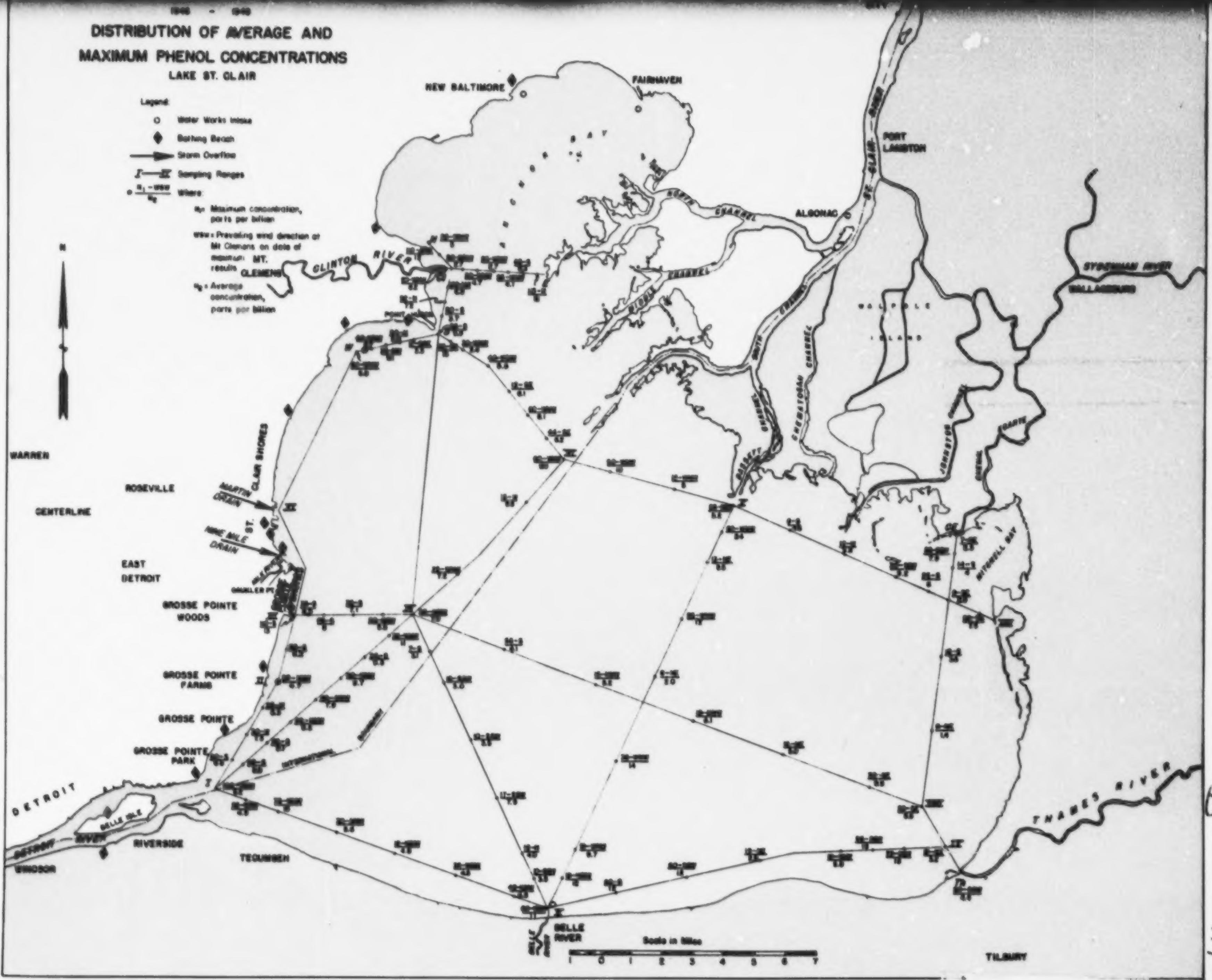
Legend:
Water Works Intake
Bathing Beach
Storm Overflow
I—II Sampling Ranges
Where
N₁ = Maximum concentration, parts per billion
WDW = Prevailing wind direction at Mt Clemens on date of maximum results
N₂ = Average concentration, parts per billion
N
NEW BALTIMORE
FAIRHAVEN
MARINE CITY
SOMBRA
PORT LAMBTON
ALGONAC
ST. CLAIR RIVER
NORTH CHANNEL
MIDDLE CHANNEL
CHENAL ECARTE
WALPOLE ISLAND
SYDENHAM RIVER
WALLACEBURG
CLINTON RIVER
MT. CLEMENS
WARREN
ROSEVILLE
CENTERLINE
ST. CLAIR SHORES
MARTIN DRAIN
NINE MILE DRAIN
EAST DETROIT
GROSSE POINTE WOODS
GROSSE POINTE FARMS
GROSSE POINTE
GROSSE POINTE PARK
DETROIT
BELLE ISLE
RIVERSIDE
TECUMSEH
THAMES RIVER
MITCHELL BAY

B

1946 - 1948

DISTRIBUTION OF AVERAGE AND MAXIMUM PHENOL CONCENTRATIONS

LAKE ST. CLAIR


Legend:
Water Works Intake
Bathing Beach
Storm Overflow
Sampling Ranges
Where:
Maximum concentration, parts per billion
Prevailing wind direction at Mt Clemens on date of maximum results
Average concentration, parts per billion
N
NEW BALTIMORE
FAIRHAVEN
ANCHOR BAY
NORTH CHANNEL
MIDDLE CHANNEL
ALGONAC
ST. CLAIR RIVER
PORT LAMBTON
SYDENHAM RIVER
WALLACEBURG
WALPOLE ISLAND
CHENAL ECARTE
JOHNSTON CHANNEL
CHEMATOGAN CHANNEL
SOUTH CHANNEL
BASSETT CHANNEL
MITCHELL BAY
MT. CLEMENS
CLINTON RIVER
WARREN
ROSEVILLE
CENTERLINE
ST. CLAIR SHORES
MARTIN DRAIN
NINE MILE DRAIN
EAST DETROIT
GAULKER PT.
GROSSE POINTE WOODS
GROSSE POINTE FARMS
GROSSE POINTE
GROSSE POINTE PARK
DETROIT
BELLE ISLE
DETROIT RIVER
RIVERSIDE
WINDSOR
TECUMSEH
BELLE RIVER
THAMES RIVER
TILBURY
Scale in Miles
1 0 1 2 3 4 5 6 7

Litho U S Lake Survey 1949

Figure 8

B

117C

(Follows Page 118)

Table 20 — SUMMARY OF AVERAGE ANALYTICAL RESULTS – LAKE ST. CLAIR

Sampling Point & Location	Station (Miles)		Coliforms MPN per 100 ml	Chlorides ppm	Phenols ppb	Ammonia as N ppm	Chlorine Demand ppm	Temp. °C	D.O. ppm	BOD 5 day ppm	Turbidity ppm	pH	Alk. ppm	Sus. ppm	Threshold Odor, Cold				Taste	Total Solids ppm	
															Raw No.	Nature	Chlorinated No.	Nature		Total	Volatile
I - II - III	0 (I)	Average	Median 9.1	6.8	6.3	.008	.27	19.6	9.68	.85	13									156	90
West Shore, Windmill		Maximum	43	11.0	100	.46	.30	25	11.4	.90	44									200	108
Pte. to Grosse Pte.		Minimum	< 1.8	4.7	0	0	.18	11.0	8.6	0	5									114	66
Shores		No. of Samples	24	23	24	20	3	19	24	24	21								6	3	3
	1.0	Average	Median 9.1	8.1	4.6	0.015	0.18	16.8	10.0	0.43	11									155	86
		Maximum	240	11.0	60	0.10	0.3	22.5	10.9	0.80	20									160	90
		Minimum	3.6	4.4	0	0	0.18	11.0	8.8	0.20	5									148	76
		No. of Samples	13	12	13	11	8	11	13	13	11								3	3	2
	2.0	Average	Median 23	8.1	7.3	0.02	0.25	16.5	9.9	0.64	11									157	88
		Maximum	430	12.0	30	0.14	0.30	22.5	10.7	1.6	20									158	88
		Minimum	2	5.8	0	0	0.20	11.0	8.5	0.23	5									156	88
		No. of Samples	13	13	13	11	8	11	13	13	11								3	3	3
	3.0	Average	Median 23	7.8	6.3	0.016	0.23	16.5	9.8	0.86	13									158	98
		Maximum	4,300	9.7	23	0.12	0.25	23.0	10.6	3.0	30									158	98
		Minimum	< 1.8	4.4	0	0	0.20	11.0	8.4	0	6									158	98
		No. of Samples	13	13	13	11	8	11	13	13	11								3	3	2
	4.0(II)	Average	Median 84	7.8	4.7	0.008	0.23	17.6	9.80	0.95	11									158	88
		Maximum	4,600	11.0	28	0.04	0.25	22.5	10.8	4.0	24									160	88
		Minimum	< 1.8	5.5	0	0	0.20	11.0	8.3	0.30	6									158	88
		No. of Samples	12	12	12	10	8	10	12	12	10								3	2	2
	5.0	Average	Median 93	7.80	6.8	0.014	0.23	17.6	9.9	0.84	9									166	84
		Maximum	1,800	12.0	55	0.08	0.30	22.5	10.8	3.6	13									172	88
		Minimum	< 2.3	5.5	0	0	0.15	11.0	8.4	0.34	5									156	88
		No. of Samples	13	13	13	11	8	11	13	13	5								3	3	3
	6.0(III)	Average	Median 350	8.1	13	0.0178	0.20	16.5	9.9	1.23	13									174	94
		Maximum	4,600	10.5	210	0.14	0.20	22.5	11.8	6.6	6									180	96
		Minimum	9.1	5.2	0	0	0.20	11.0	8.0	0.23	30									168	98
		No. of Samples	13	14	14	12	8	12	14	14	12								3	3	3
III - XI	6.0	For	Point III,	Refer	to	Range	I -	II -	III												
Grosse Pte. Yacht	6.5	Average	Median 210	7.6	0	0.0013		12.8	10.2	0.65	28										
Club to St. Clair		Maximum	>2,400	8.5	0	0.004		13.0	10.8	1.0	42										
Shores Light		Minimum	43	7.2	0	0		11.0	9.9	0.41	19										
Buoy		No. of Samples	3	3	3	3		3	3	3	3										
	7.5	Average	Median 93	7.1	0	0		12.8	10.1	0.61	22										
		Maximum	150	8.0	0	0		13.0	10.5	0.6	38										
		Minimum	75	6.4	0	0		11.0	9.9	0.38	11										
		No. of Samples	3	3	3	3		3	3	3	3										
	8.5	Average	Median 23	6.3	0	0		12.8	10.1	0.303	13										
		Maximum	43	7.0	0	0		13.0	10.6	0.48	16										
		Minimum	9.1	6.0	0	0		11.0	9.7	0.19	10										
		No. of Samples	3	3	3	3		3	3	3	3										
III - IV - VIII	0.0(III) 0.5	Average	Median 23	7.8	6.5	0.009	0.25	15.4	9.9	0.87	9									157	88
Grosse Pte. Yacht Club		Maximum	4,600	8.8	30	0.04	0.30	22.5	11.8	6.6	16									166	94
to Buoy 23 to outer		Minimum	< 1.8	4.6	0	0	0.20	12.5	8.4	0.14	5									140	80
Thames Buoy		No. of Samples	11	11	11	9	8	9	11	11	9								3	2	2
	1.0	Average	Median 43	8.1	8	0.008	0.75	16.8	10	0.79	7									180	79
		Maximum	460	11.0	65	0.04	1.3	23.0	10.8	3.0	16									186	80
		Minimum	3.6	4.8	0	0.01	0.20	12.0	8.7	0.28	4									144	76
		No. of Samples	11	11	11	9	8	9	11	11	8								3	3	3

Table 20 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – LAKE ST. CLAIR (continued)

Sampling Point & Location	Station (Miles)		Coliform MPN per 100ml	Chlorides ppm	Phenols ppb	Ammonia N ppm	Chlor. Dem. ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm	Turbidity ppm	pH	Alk. ppm	[illegible] ppm	Threshold Odor, Cold				Taste	Total Solids ppm	
															Raw		Chlorinated				
															No.	Nature	No.	Nature		Total	Volatile
	2.0	Average	Median 52	7.6	7.1	0.056	0.30	[illegible]	10.1	0.68	7									151	72
		Maximum	95	11.3	30	0.06	0.30	25.0	11.8	3.0	18									158	70
		Minimum	< 1.8	5.1	0	0	0.10	11.0	8.7	0.21	5									146	66
		No. of Samples	11	11	11	9	3	9	11	11	9									[illegible]	3
	3.0	Average	Median 48	7.7	5.5	0.008	0.18	[illegible]	10.3	1.07	7									157	88
		Maximum	240	10.3	20	0.01	0.25	25.0	11.3	3.8	9									160	96
		Minimum	< 1.8	4.9	0	0	0.10	11.0	8.6	0.18	6									154	80
		No. of Samples	11	11	11	9	3	9	11	11	9								3	3	3
	4.0(IV)	Average	Median 46	7.8	7.0	0.008	0.20	[illegible]	10.0	0.49	9									141	80
		Maximum	460	11.0	28	0.06	0.25	25.5	8.6	4.0	53									158	90
		Minimum	< 1.8	4.1	0	0	0.15	11.0	11.4	0	3									118	72
		No. of Samples	26	26	24	20	3	20	26	26	24								6	3	3
III - IV - VIII	7.0	Average	Median 9.1	6.0	10.0	0.0020	0.18	[illegible]	9.5	0.84	7									152	84
Grosse Pte. Yacht Club		Maximum	190	11.5	30	0.01	0.25	22.5	11.0	2.4	9									156	88
to Buoy 26 to outer		Minimum	< 1.8	4.3	0	0	0.10	14.0	8.6	0.28	4									150	80
Thames Buoy		No. of Samples	6	6	6	4	3	3	6	6	6								3	3	3
	10.0	Average	Median 3.6	6.9	5.8	0.007	0.23	20.9	9.5	0.41	10										
		Maximum	18	8.4	18	0.06	0.30	24.8	10.4	0.66	22										
		Minimum	2	5.1	0	0	0.15	18.8	8.4	0	4										
		No. of Samples	7	6	6	4	3	3	6	6	6								3		
	13.0	Average	Median 5.3	6.8	4.1	[illegible]	0.33	[illegible]	8.9	2.1	19									174	118
		Maximum	3.6	8.4	18	0.06	0.60	25.0	9.4	3.0	48									208	124
		Minimum	< 1.8	5.3	0	0	0.15	18.0	8.0	0.14	4									180	112
		No. of Samples	6	6	6	4	3	5	6	6	6								3	3	3
	16.0	Average	Median 3.6	5.7	3.0	0.018	0.30	20.1	8.9	0.86	17									188	111
		Maximum	30	7.1	18	0.06	0.50	25.5	9.4	1.8	30									200	120
		Minimum	< 1.8	1.2	0	0	0.20	16.5	8.3	0.06	3									184	102
		No. of Samples	6	6	6	4	3	5	6	6	6								3	3	3
	19.0	Average	Median 2.3	4.6	9.75	0.018	0.30	[illegible]	8.9	0.86	19									195	105
		Maximum	45	6.9	30	0.06	0.30	25.0	9.6	2.6	47									196	104
		Minimum	< 1.8	5.0	0	0	0.20	16.5	8.2	0.16	3									190	102
		No. of Samples	6	6	6	6	3	5	6	6	6								3	3	3
	21.0(VIII)		For Point VIII, Refer to Range Th - IX - VIII - CS																		
I - IV - VI	0.0(I) 1.0	Average	For Point I, Refer to Ranges I - II - III Median 13	6.8	6.8	0.021	0.20	[illegible]	9.9	0.30	6										
Ship Channel, Windmill		Maximum	240	9.0	56	0.01	0.20	21.5	11.4	2.6	15										
Pte. to St. Clair Flats		Minimum	3.6	5.1	0	0	0.20	11.0	8.7	0.15	6									152	92
		No. of Samples	12	12	12	11	1	10	12	12	10								4	1	1
	2.0	Average	Median 25	7.2	3.7	0.083	0.25	[illegible]	9.9	2.2	9									144	68
		Maximum	95	8.6	36	0.18	0.25	22.0	11.4	8.4	14									148	74
		Minimum	2	5.4	0	0	0.20	11.6	8.8	0	3									140	56
		No. of Samples	13	13	13	11	2	10	13	13	11								4	3	3
	3.0	Average	Median 42	7.3	9.2	0.033	0.23	16.1	9.2	0.37	9									138	80
		Maximum	190	8.8	42	0.33	0.25	22.0	10.8	1.8	21									190	90
		Minimum	2	3.4	0	0	0.20	12.0	8.7	0.23	4									120	70
		No. of Samples	13	13	13	11	2	10	13	13	11								4	3	3
	4.0	Average	Median 23	6.9	7.9	0.033	0.23	[illegible]	9.8	0.42	9									160	-
		Maximum	95	8.4	23	0.18	0.25	22.0	11.0	1.0	11									184	-
		Minimum	1.8	5.6	0	0	0.20	12.0	8.7	0.20	3									126	76
		No. of Samples	13	13	13	11	2	10	13	13	11								4	3	1

Table 20 - SUMMARY OF AVERAGE ANALYTICAL RESULTS - LAKE ST. CLAIR (continued)

Sampling Point & Location	Station (Miles)		Coliform MPN per 100 ml	Chlorides ppm	Phenols ppb	Ammonia as N ppm	Chlor. Dem. ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm	Turbidity ppm	pH	Alk. ppm	[illegible] ppm	Threshold Odor, [illegible]				Taste	Total Solids ppm	
															[illegible]	[illegible]	[illegible]	[illegible]		Total	Volatile
	[illegible]	Average	Median 9.3	7.8	9.7	0.030	0.35	19.6	9.5	0.9	8									158	86
		Maximum	130	8.7	60	0.04	0.60	22.5	10.8	2.0	18									170	90
		Minimum	2.0	6.8	0	0	0.20	11.5	8.8	0	5									138	75
		No. of Samples	13	13	13	11	8	10	13	13	13								6	3	3
I - IV - VI (Cont'd)	6.0	Average	Median 33.0	7.5	9.5	0.032	0.30	19.5	9.8	0.41	9									147	7[illegible]
Ship Channel, Windmill		Maximum	1,100	9.9	28	0.06	0.[illegible]	24.0	11.3	1.4	15									160	[illegible]
Pte. to St. Clair Flats		Minimum	1.8	6.1	0	0	[illegible]	12.0	8.8	0	5									136	76
		No. of Samples	13	13	13	11	8	10	13	13	11								6	3	3
	7.0	Average	Median 28	7.3	11.1	0.030	0.30	19.5	10.0	0.36	9									141	70
		Maximum	>2,400	9.3	30	0.06	0.30	25.0	12.0	1.3	24									168	108
		Minimum	1.8	5.8	0	0	0.10	11.5	8.6	0.16	6									130	36
		No. of Samples	13	13	13	11	8	10	13	13	11								6	3	3
	8.0(IV)	For	Point IV	Refer	to	Range	III -	IV -	VIII												
	10.0	Average	Median 30	7.0	7.8	0.017	0.25	19.0	10.3	0.60	8									158	91
		Maximum	1,100	10.3	25	0.16	0.35	24.5	11.6	2.4	19									180	106
		Minimum	< 3.5	4.8	0	0	0.20	12.0	8.9	0.10	4									140	78
		No. of Samples	11	11	11	9	8	9	11	11	11								3	3	3
	13.0	Average	Median 33	6.3	5.5	0.008	0.23	19.5	10.4	0.46	8									151	96
		Maximum	>2,400	8.5	18	0.01	0.30	25.0	11.3	1.4	17									156	96
		Minimum	< 3.5	4.5	0	0	0.15	14.0	8.9	0.25	5									148	90
		No. of Samples	11	11	11	9	8	9	11	11	11								3	3	3
	15.0(VI)	Average	Median [illegible]	6.9	9.0	0.0030	0.30	19.5	10.0	0.42	8									110	49
		Maximum	>2,400	7.6	60	0.008	0.35	26.5	13.8	3.0	21									144	74
		Minimum	1.8	4.8	0	0	0.15	11.0	7.4 6.5	0	2									80	30
		No. of Samples	25	27	27	25	8	20	27	27	27								10	3	3
IV - 8	0.0(IV)	Average	For Point 130	IV. 5.8	Refer 1	to 0	Range	III	- IV - 10.3	VIII. 0.41	10										
Buoy 23 to Point Huron	2.0	Maximum	240	6.8	2	0			10.9	0.58	13										
		Minimum	23	4.7	0	0			10.7	0.30	7										
		No. of Samples	2	2	2	2			2	2	2										
	4.0	Average	Median 380	6.5	3.5	0.08			10.75	0.44	15										
		Maximum	750	6.8	5	0.04			10.8	0.48	16										
		Minimum	9.1	6.2	0	0			10.7	0.40	9										
		No. of Samples	2	2	2	2			2	2	2										
	6.0	Average	Median 160	6.3	1	0			10.7	0.39	13										
		Maximum	240	6.9	2	0			10.8	0.44	13										
		Minimum	75	5.5	0	0			10.5	0.38	10										
		No. of Samples	2	2	2	2			2	2	2										
	8.0	Average	Median 140	6.0	1	0			11.0	0.45	10										
		Maximum	240	6.8	2	0			11.1	0.46	11										
		Minimum	43	6.0	0	0			10.9	0.44	9										
		No. of Samples	2	2	2	2			2	2	2										
I - V - IX	0.0(I)	For	Point I,	Refer	to	Range	I -	II	- III												
South Shore, Windmill	2.0	Average	Median 9.1	6.8	4.9	0.005	0.25	16.5	9.75	0.35	10									159	81
Pte. to Belle River,		Maximum	68	13.0	25	0.06	0.30	23.0	11.4	0.59	24									190	88
Canada to Thames		Minimum	< 1.8	4.2	0	0	0.15	11.0	8.0	0	6									130	70
River		No. of Samples	14	14	14	13	8	11	14	14	12								3	3	3
	3.0	Average	Median 4.5	6.7	16.5	0.05	0.30	[illegible]	9.7	0.44	10									161	84
		Maximum	43	11.0	75	0.28	0.35	24.0	10.8	1.6	19									178	96
		Minimum	< 1.8	4.3	0	0	0.15	12.0	8.7	0.02	5									150	74
		No. of Samples	15	15	15	11	8	11	15	15	11								6	3	3

Table 20 —SUMMARY OF AVERAGE ANALYTICAL RESULTS— LAKE ST. CLAIR (continued)

Sampling Point & Location	Station (miles)		Coliform MPN per 100 ml	Chlorides ppm	Phenol ppb	Ammonia as N ppm	Chlo Dem ppm	Temp °C	D.O. ppm	B.O.D. 5 day ppm	Turbidity ppm	pH	Alk. ppm	Oils ppm	Threshold Odor, Cold: Raw No.	Raw Descrip.	Chlorinated No.	Chlorinated Descrip.	Taste	Total Solids ppm Total	Total Solids ppm Volatile
	4.8	Average	Median 3.6	5.5	5.0	0.050	0.58	[illegible]	9.8	0.41	11									166	77
		Maximum	16	5.6	20	0.06	0.80	24	10.7	0.80	17									179	84
		Minimum	< 1.8	4.8	0	0	0.18	18	6.7	0.06	6									152	90
		No. of Samples	16	16	16	15	8	11	16	16	13								6	8	8
	6.0	Average	Median 3.6	6	4.8	0.008	0.80	[illegible]	9.6	0.51	11									154	75
		Maximum	9.1	7.6	10	0.08	0.85	25.0	10.9	0.60	38									160	[illegible]
		Minimum	1.8	5.4	0	0	0.18	11.0	8.0	0	6									148	94
		No. of Samples	13	13	13	10	8	9	13	13	10								5	8	8
	8.8	Average	Median < 2.3	6.4	4.6	0.089	0.80	19.0	9.6	0.88	13									140	75
		Maximum	15	9.7	30	0.83	0.85	25.0	11.3	0.88	38									158	90
		Minimum	< 1.8	5.4	0	0	0.15	10.8	8.5	0	6									144	80
		No. of Samples	13	13	13	10	8	9	13	13	10								5	8	8
	10.0	Average	Median 3.6	6.3	6.75	0.087	0.85	19.0	9.8	0.39	14										
		Maximum	23	8.5	40	0.24	0.90	25.5	11.8	[illegible]	30										
		Minimum	< 1.8	4.0	0	0	0.80	11.0	8.4	0	5										
		No. of Samples	14	13	13	10	8	9	13	13	10								8		
I - V - II (Cont'd) South Shore, Windmill Pte. to Belle River, Canada, to Thames River	11.0(V)	Average	Median 9.1	6.3	11.8	0.06	0.85	[illegible]	9.8	8.8	15									178	111
		Maximum	240	8.5	60	0.18	0.40	26.0	10.5	3.5	45									188	186
		Minimum	< 1.8	4.8	0	0	0.15	16.5	8.0	0.28	4									156	96
		No. of Samples	13	11	13	8	2	8	13	13	11								4	8	8
	13.5	Average	Median 3.6	6.7	12.4	0.053	0.70	[illegible]	9.3	7.9	12									199	118
		Maximum	9.1	7.6	60	0.18	0.95	[illegible]	10.0	3.0	25									216	106
		Minimum	2	5.1	0	0	0.50	17.5	8.1	0.13	4									188	118
		No. of Samples	8	7	8	6	2	5	8	8	8								2	8	8
	16.0	Average	Median 3.6	6.6	11.6	0.014	0.48	[illegible]	9.1	0.64	15									198	95
		Maximum	9.1	7.8	60	0.06	0.50	25.5	9.6	2.4	26									204	76
		Minimum	< 1.8	5.2	0	0	0.45	17.5	8.3	0.16	5									188	114
		No. of Samples	8	7	8	6	2	5	8	8	8								2	2	8
	18.5	Average	Median 3.6	6.1	2.75	0.007	0.40	[illegible]	9.1	7.9	16									208	114
		Maximum	31	7.4	12	0.04	[illegible]	25.5	9.8	2.8	38									220	106
		Minimum	< 2.3	4.6	0	0	0.40	17.5	8.0	0.10	6									188	122
		No. of Samples	8	7	8	6	2	5	8	8	8								2	8	8
	21.0	Average	Median 3.6	6.3	5.75	0.014	0.53	[illegible]	9.1	0.81	17									207	121
		Maximum	150	7.8	18	0.04	0.80	17.5	9.6	2.0	38									238	124
		Minimum	1	4.4	0	0	0.45	25.5	8.1	0.20	4									188	116
		No. of Samples	8	7	8	6	2	5	8	8	8								8	8	2
	22.0	Average	Median 3.6	6.2	17.9	0.08	0.60	[illegible]	8.95	7.1	22									191	108
		Maximum	930	8.3	95	0.16	0.70	26.5	9.6	1.8	77									198	98
		Minimum	< 1.8	4.2	0	0	0.50	17.5	8.2	0.26	5									190	120
		No. of Samples	7	7	8	6	2	5	8	8	8								2	2	2
	25.0	Average	Median 3.6	6.1	7	0.05	0.45	[illegible]	8.65	6.15	20									179	97
		Maximum	930	6.0	25	0.13	0.60	25.5	9.6	1.6	60									200	128
		Minimum	2.0	4.2	0	0	0.30	17.5	8.3	0.20	5									150	68
		No. of Samples	8	7	8	8	8	5	8	8	8								2	8	2
	24.0(II)		For Point II,	Refer	to	Range	Th -	IX -	VIII	- CE.											
V - IV	0.0(V)	Average	Median 9.1	6.3	11.8	0.06	0.85	[illegible]	9.8	8.8	15									178	111
		Maximum	240	8.5	60	0.18	0.40	26.0	10.5	3.5	45									188	186
		Minimum	< 1.8	4.8	0	0	0.15	16.5	8.0	0.28	6									156	96
		No. of Samples	13	11	13	8	2	8	13	13	11									8	8

Table 20 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – LAKE ST. CLAIR (continued)

Sampling Point & Location	Station (Miles)		Coliforms MPN per 100ml	Chlorides ppm	Phenols ppb	Amm. as N ppm	Chlor. Dem. ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm	Turbidity ppm	pH	Alk. ppm	Oils ppm	Threshold Odor, Cold: Raw No.	Raw Natures	Chlorinated No.	Chlorinated Natures	Taste	Total Solids ppm Total	Total Solids ppm Volatile
Belle River to Buoy	1.0	Average	Median 5	6.7	3.6	0.015	0.25	19.0	9.6	0.29	14									159	82
28 (Ship Channel)		Maximum	43	9.3	10	0.09	0.30	24.0	10.6	0.90	27									152	73
		Minimum	< 1.8	4.7	0	0	0.20	13.0	8.4	0	4									146	92
		No. of Samples	8	8	8	6	2	6	8	8	7								2	2	2
	2.0	Average	Median < 2.3	6.5	4	0.014	0.20	19.0	9.8	0.36	13									167	72
		Maximum	23	9.2	15	0.06	0.25	26.0	11.5	0.66	29									190	86
		Minimum	<1.8	4.8	0	0	0.15	11.5	8.7	0	4									144	58
		No. of Samples	8	8	8	6	2	6	8	8	7								2	2	2
V - IV (Cont'd)	4.0	Average	Median < 2.3	6.7	7.9	0.011	0.18	19.5	9.6	0.39	13									145	74
Belle River to Buoy 28		Maximum	43	9.5	17	0.06	0.25	25.5	11.0	0.47	33									152	86
(Ship Channel)		Minimum	< 1.8	4.6	0	0	0.10	12.5	8.5	0	4									138	62
		No. of Samples	8	8	8	6	2	6	8	8	7								2	2	2
	6.0	Average	Median 38	7.1	3.5	0.013	0.20	19.5	9.9	0.31	8									149	88
		Maximum	93	8.3	10	0.08	0.30	25.0	10.8	0.59	15									150	70
		Minimum	< 1.8	5.2	0	0	0.10	15.0	8.7	0	4									148	94
		No. of Samples	8	8	8	6	2	6	8	8	7								2	2	2
	8.0	Average	Median 150	7.0	3.0	0.008	0.25	19.0	10.2	0.43	9									150	79
		Maximum	>2,400	9.8	10	0.06	0.30	25.0	11.2	1.0	15									152	90
		Minimum	1.8	5.0	0	0	0.15	11.0	8.9	0.02	5									148	68
		No. of Samples	10	10	10	7	2	6	10	10	9								2	2	2
	9.0	Average	Median 28	7.1	3.1	0.001	0.25	16.5	10.2	0.45	7									148	70
		Maximum	280	11.0	7	0.01	0.30	26.0	11.4	1.2	11									152	78
		Minimum	<1.8	6.1	0	0	0.15	11.0	9.0	0.34	4									144	62
		No. of Samples	10	10	10	8	2	8	10	10	9								2	2	2
	10.0(IV)	For	Point IV,	Refer	to	Range	III -	IV -	VIII												
Th - IX - VIII - CE	0.0(Th)	Average	Median 490	11.3	4.4	0.053	0.65	22.0	7.6	1.7	29									380	215
East Shore, Thames River		Maximum	11,000	19.2	20.	0.16	0.80	27.5	10.4	3.8	65									440	252
to outer Thames Buoy to		Minimum	3.7	6.2	0	0	0.50	17.5	5.4	0.64	10									340	178
Chenal Ecarte		No. of Samples	11	9	11	8	2	7	11	11	10								5	2	2
	1.0(III)	Average	Median 53	7.3	3.2	0.02	0.60	23.0	6.7	0.96	23									208	112
		Maximum	2,400	10.8	15	0.10	0.80	26.5	10.4	2.6	52									230	120
		Minimum	< 2.3	4.5	0	0	0.40	17.0	7.4	0.40	7									180	104
		No. of Samples	10	9	10	8	2	7	10	10	10								5	2	2
	2.5(III)	Average	Median 4	6.6	5.5	0.016	0.40	22.5	8.1	0.85	20									182	112
		Maximum	150	8.5	20	0.05	0.60	25.5	9.6	3.0	75									208	124
		Minimum	< 2.3	4.8	0	0	0.35	17.0	6.1	0.27	5									156	94
		No. of Samples	11	11	11	9	3	6	12	12	12								4	3	3
	5.0	Average	Median < 2.3	6.7	1.4	0.006	0.38	23.6	8.7	0.58	9									178	103
		Maximum	15	7.8	6	0.05	0.40	27.0	9.2	1.8	24									180	102
		Minimum	< 1.8	6.0	0	0	0.35	20.0	8.1	0	5									172	104
		No. of Samples	7	6	7	5	2	5	7	7	7								3	2	2
	7.5	Average	Median 3.1	6.9	3.6	0	0.40	24.5	9.2	0.06	12									165	105
		Maximum	9.1	8.0	18	0	0.50	27.5	10.0	2.4	49									154	94
		Minimum	1	5.8	0	0	0.30	18.0	8.6	0	4									162	118
		No. of Samples	5	6	7	5	2	5	7	7	7								3	2	2
	10.5	Average	Median 95	6.3	4	0.006	0.51	22.0	9.7	0.94	12									149	74
		Maximum	460	7.8	14	0.02	0.87	27.5	10.6	3.2	21									174	52
		Minimum	1.0	5.0	0	0	0.30	12.0	8.3	0.09	4									116	62
		No. of Samples	9	7	9	6	3	6	9	9	9								5	3	3

Table 20 —SUMMARY OF AVERAGE ANALYTICAL RESULTS— LAKE ST. CLAIR (continued)

Sampling Point & Location	Station (Miles)		Coliforms MPN per 100 ml	Chlorides ppm	Phenols ppb	Amm. as N ppm	Chlor. Dem. ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm	Turbidity ppm	pH	Alk. ppm	Oils ppm	Threshold Odor, Cold				Taste	Total Solids ppm	
															Raw		Chlorinated				
															No	Nature	No	Nature		Total	Volatile
Th - IX - VIII - CE (Cont'd)	11.0	Average	Median 340	6.8	7.9	0.03	0.58	22.5	9.5	0.74	18.7									165	85
East Shore, Thames River		Maximum	980	8.0	25	0.01	1.1	28.0	10.5	3.0	60									204	84
to outer Thames Buoy		Minimum	7.8	5.4	0	0	0.30	12.0	8.1	0.20	5									188	78
to Chenal Ecarte		No. of Samples	9	7	9	6	3	6	9	9	9								3	3	3
	11.8(XI)	Average	Median 340	6.4	8.3	0.008	0.45	20.0	9.4	0.56	15									[illegible]	
		Maximum	2,400	7.4	7	0.01	0.80	23.0	10.8	1.0	27									188	118
		Minimum	35	5.0	0	0	0.25	14.5	8.2	0	8									160	110
		No. of Samples	8	6	7	5	3	5	8	8	7								3	3	3
VII - X - VI	0(VII)	Average																			
Mitchell Pte. to St. Clair		Maximum																			
Flats		Minimum	2	8.7	16		0.35		9.8	0.80	9									160	104
		No. of Samples	1	1	1		1		1	1	1									1	1
	0.5	Average	Median 3.6	6.7	7.8	0.008	0.75	21.5	9.6	0.87	11									179	48
		Maximum	79	8.5	20	0.08	1.10	28.5	10.8	1.4	21									198	80
		Minimum	1.8	4.7	0	0	0.40	11.0	8.0	0.48	5									166	76
		No. of Samples	8	7	8	6	2	6	8	8	8								4	2	2
	1.5	Average	Median 8.7	6.6	2.9	0.001	0.75	22.5	9.5	8.9	9									192	79
		Maximum	130	7.6	9	0.004	1.20	27.5	10.3	2.6	15									192	106
		Minimum	1.8	5.3	0	0	0.30	11.0	8.3	0.14	3									192	36
		No. of Samples	8	7	8	6	2	6	8	8	8								4	2	2
	2.5	Average	Median 3.6	6.25	6	0.05	0.73	21.0	9.7	0.94	10									202	73
		Maximum	- 49	7.8	85	0.26	1.10	26.5	11.4	2.8	18									206	54
		Minimum	1.8	5.1	0	0	0.35	11.0	8.8	0.50	7									198	92
		No. of Samples	7	6	7	5	2	5	7	7	7								3	2	2
	3.5	Average	Median <23	6.55	9.2	0.001	0.70	17.0	10.3	1.39	9									153	58
		Maximum	11	8.3	30	0.004	1.10	23.5	11.6	3.6	15									206	38
		Minimum	1.8	5.1	2	0	0.30	11.0	8.8	0.42	7									100	78
		No. of Samples	5	4	5	3	2	3	5	5	5								1	2	2
	5.5	Average	Median 15	6.3	3.8	0	0.23	19.0	10	0.37	6									132	49
		Maximum	93	7.6	12	0	0.25	24.0	11.5	0.66	9									136	62
		Minimum	< 1.8	5.1	0	0	0.21	11.0	9.1	0	3									128	36
		No. of Samples	8	7	6	6	2	5	8	8	8								4	2	2
	7.5	Average	Median 9.1	6.65	4.6	0	0.29	20.5	10.1	0.53	5									121	48
		Maximum	23	8.0	8	0	0.38	26.5	11.5	1.4	7									138	46
		Minimum	1.8	5.2	0	0	0.20	11.0	8.9	0	2									104	50
		No. of Samples	7	6	7	5	2	5	7	7	7								3	2	2
	9.5(X)	Average	Median 9.1	6.2	5.2	0.007	0.27	16.0	10.1	0.65	5									122	50
		Maximum	1,100	7.8	25	0.05	0.30	26.5	11.4	2.2	8									154	86
		Minimum	<2.5	4.5	0	0	0.19	11.0	7.9	0	2									86	24
		No. of Samples	11	9	11	7	4	7	11	11	11								4	3	3
	11.5	Average	Median 3.6	6.12	5	0	3.82	16.5	9.7	0.42	6									102	40
		Maximum	43	7.6	15	0	7.3	26.5	10.7	1.0	12									124	56
		Minimum	1.8	4.7	0	0	0.35	11.0	8.8	0.	3									80	24
		No. of Samples	11	10	11	10	2	8	11	11	11								4	2	2
	13.5	Average	Median 8.3	6.2	10.1	0.002	4.9	19.2	9.86	0.44	7									110	50
		Maximum	93	8.3	50	0.02	9.4	26.0	8.7	0.80	11									128	76
		Minimum	1.8	4.7	0	0	0.38	11.0	10.8	0.18	2									92	24
		No. of Samples	12	11	12	11	2	9	12	12	12								4	2	2
	15.0(VI)	For	Point VI,	Refer	to	Range	I -	IV -	VI												

Table 20 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – LAKE ST. CLAIR (continued)

Sampling Point & Location	Station (Miles)		Coliforms MPN per 100ml	Chlorides ppm	Phenols ppb	Ammonia as N ppm	Nitrate N ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm	Turbidity ppm	pH	Alk. ppm	Oils ppm	Threshold Odor, Cold				Taste	Total Solids ppm	
															Raw		Chlorinated				
															No.	Nature	No.	Nature		Total	Volatile
I - V	0.0(I)	Average	Median 9.1	6.8	8.8	0.007	0.27	[illegible]	10.1	0.80	5									128	80
Mouth of Duckett Channel		Maximum	1,150	7.0	20	0.05	0.30	20.5	11.4	2.2	8									154	[illegible]
to Belle River		Minimum	< 2.3	4.8	0	0	0.10	11.0	7.0	0	2									86	
		No. of Samples	11	9	11	7	4	7	11	11	11									3	3
	1.0	Average	Median 28	6.7	26	0.02	0.20	17.0	10.8	0.85	8										
		Maximum	240	9.2	60	0.06	0.20	20.0	11.1	1.8	9										
		Minimum	< 1	5.4	0	0	0.20	14.0	9.2	0.10	6									148	[illegible]
		No. of Samples	4	3	4	2	2	2	4	4	4								1	1	2
	2.0	Average	Median 5	6.1	5.5	0	0.30	[illegible]	9.9	1.42	6									152	76
		Maximum	9.1	7.4	15	0	0.30	20	10.4	2.9	7									160	76
		Minimum	< 1	5.3	0	0	0.30	17.0	9.4	0.84	6									144	76
		No. of Samples	4	3	4	2	2	2	4	4	4								1	2	2
	4.0	Average	Median < 2.3	6.5	12	0.003	0.35	[illegible]	9.3	6.7	11									164	83
		Maximum	3.3	6.7	25	0.006	0.45	20	10.0	2.5	17									186	100
		Minimum	1.0	5.0	7	0	0.20	17.5	9.1	0	4									142	66
		No. of Samples	4	3	4	2	2	2	4	4	4								1	2	2
	6.0	Average	Median 1.0	6.9	8	0.003	0.35	[illegible]	9.6	0.55	10									182	90
		Maximum	< 2.3	8.7	8	0.008	0.40	19.5	10.4	1.0	18									238	140
		Minimum	< 1.0	5.1	0	0	0.30	16.5	9.0	0.25	7									136	40
		No. of Samples	4	4	4	2	2	2	4	4	4								1	2	2
	9.0	Average	Median < 2.3	6.6	14.5	0.004	0.33	[illegible]	9.4	1.47	16									170	90
		Maximum	3.3	8.7	35	0.008	0.45	21.0	10.0	3.0	26									194	104
		Minimum	1.0	5.2	2	0	0.20	18.0	8.9	0.20	4									146	76
		No. of Samples	4	3	4	2	2	2	4	4	4								1	2	2
	12.0	Average	Median 2	3.6	9.7	0.005	0.45	[illegible]	9.2	1.29	17									192	107
		Maximum	< 2.3	4.9	18	0.01	0.45	21.5	9.7	3.9	24									200	114
		Minimum	< 1.0	2.4	6	0	0.45	19.0	8.8	0.04	8									184	100
		No. of Samples	4	3	4	2	2	2	4	4	4								1	2	2
	15.0	Average	Median < 2.3	5.4	11.8	0.003	0.50	[illegible]	9.3	1.01	15									206	110
		Maximum	5.5	6.4	18	0.006	0.55	20.5	9.5	2.1	15									228	124
		Minimum	1.0	4.4	5	0	0.45	18.5	8.9	0.44	14									184	96
		No. of Samples	4	3	4	2	2	2	4	4	4								1	2	2
	15.0	For	Point V,	Refer	to	Range	I -	V -	IX.												
CL - I	0.0(CL)	Average	Median 2,400	29.2	8.2	0.16	0.30	[illegible]	8.15	1.90	35										
Mouth of Clinton River		Maximum	24,000	150	50	0.40	0.30	26.0	11.9	4.1	140									[illegible]	118
to Strawberry Island		Minimum	< 1.8	6.4	0	0	0.30	11.0	4.7	0.18	5									146	
		No. of Samples	20	19	20	18	2	17	20	20	19								7	1	1
	0.5	Average	Median 9.1	7.3	2.7	0.006	0.30	19.0	[illegible]	[illegible]	13										
		Maximum	4,600	10.2	20	0.06	0.30	[illegible]	11.2	1.6	56										
		Minimum	< 1.8	5.3	0	0	0.30	11.0	6.2	0.02	3									[illegible]	100
		No. of Samples	17	18	18	7	1	16	18	18	18								6	1	1
	1.0	Average	Median 23	7.3	4.7	0.005	0.25	[illegible]	10.1	0.385	8										
		Maximum	930	11.1	20	0.06	0.25	26.5	11.7	1.0	15										
		Minimum	< 1.8	5.6	0	0	0.25	11.0	8.9	0.16	4									[illegible]	66
		No. of Samples	16	16	16	15	1	14	16	16	16								5	1	1
	1.5	Average	Median 340	7.4	2.7	0.001	0.30	17.0	10.2	3.9	9										
		Maximum	930	12.1	25	0.01	0.30	25.0	11.7	1.4	30										
		Minimum	43	5.6	0	0	0.30	11.0	9.2	0.04	3									170	62
		No. of Samples	16	17	17	16	1	15	17	17	17								6	1	1

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Table 20—SUMMARY OF AVERAGE ANALYTICAL RESULTS—LAKE ST. CLAIR (continued)

Sampling Point & Location	Dist. (Miles)		Coliforms MPN per 100 ml	Chlorides ppm	Phenols ppb	Ammonia as N ppm	Chlor. Dem. ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm	Turbidity ppm	pH	Alk ppm	Chlo ppm	Threshold Odor, Cold				Taste	Total Solids ppm	
															Raw		Chlorinated				
															No	Nature	No	Nature		Total	Volatile
	2.0	Average	Median 430	7.8	4.1	0	0.30	17.0	9.0	0.80	8										
		Maximum	2,400	11.7	25	0	0.30	25.5	11.6	6.2	17										
		Minimum	240	5.1	0	0	0.30	9.5	8.3	0.12	5									136	70
		No. of Samples	16	16	16	5	1	14	16	16	16								7	1	1
Cl - E	2.5	Average	Median 430	7	6.25	0.016	0.25	17.0	9.97	0.397	8										
Mouth of Clinton River		Maximum	2,400	11.1	65	0.20	0.25	25.5	11.7	0.85	28										
to Strawberry Island		Minimum	93	5.0	0	0	0.25	10.0	8.3	0.04	2									116	60
		No. of Samples	16	16	16	15	1	14	16	16	16								6	1	1
	3.0(E)	Average	Median 930	7.3	18.1	0.003	0.30	19.5	9.9	9.1	8										
		Maximum	1,100	12.0	215	0.04	0.30	25.5	11.4	9.8	28										
		Minimum	78	5.0	0	0	0.30	10.0	8.3	0	4									160	108
		No. of Samples	15	15	15	14	1	13	16	15	15								6	1	1
Cl - N	0.0(Cl)		For Point	Cl,	Refer	to Range	Cl	- E.													
Belvidere Bay	0.5	Average	Median 18	8.3	11.5	0.008	0.25	21.0	9.7	0.42	13										
		Maximum	1,100	20.0	110	0.08	0.25	28.0	10.9	1.4	48										
		Minimum	< 1.8	5.9	0	0	0.25	11.0	8.3	0.12	4									138	80
		No. of Samples	13	13	13	12	1	13	13	13	13								7	1	1
	1.0(N)	Average	Median 23	7.8	5		0.50	22.0	9.5	0.71	18										
		Maximum	430	12.5	23	0.24	0.50	28.0	10.7	2.0	40										
		Minimum	< 1.8	5.7	0	0	0.50	11.0	8.0	0.18	5									156	176
		No. of Samples	13	13	13	12	1	12	13	13	13								7	1	1
Cl - S	0.0(Cl)		For Point	Cl,	Refer	to	Range	Cl-E.													
Mouth of Clinton	0.5	Average	Median 43	6.0	6.8	0.047	0.25	18.5	9.8	0.55	16										
River to Point Huron		Maximum	4,300	18.1	200	0.26	0.25	27.5	10.9	1.5	60										
		Minimum	< 1.8	5.7	0	0	0.25	11.0	6.4	0.21	3									120	48
		No. of Samples	18	18	18	17	1	16	17	17	18								7	1	1
	1.0	Average	Median 23	7.3	7.2	0.02	0.35	16.5	10.1	0.43	12										
		Maximum	1,500	11.3	52	0.30	0.35	27.5	10.9	1.2	50										
		Minimum	< 1.8	5.4	0	0	0.35	11.0	9.4	0	4									110	46
		No. of Samples	18	18	18	17	1	16	18	18	18								7	1	1
	1.5	Average	Median 33	7.5	3.67	0.02	0.37	18.0	9.9	0.53	12										
		Maximum	4,300	11.1	20	0.16	0.37	28.5	10.9	1.6	58										
		Minimum	< 1.6	6.0	0	0	0.37	11.0	8.5	0	4									120	54
		No. of Samples	18	18	18	17	1	16	18	18	18								7	1	1
	2.0(S)		For	Point	S -	Refer	to	Range	S -	V1											
S - V1		Average	Median 93	9.4	5.8	0.035	0.25	16.5	9.4	0.80	23										
Point Huron South East	2.0(S)	Maximum	24,000	23.0	36	0.34	0.25	27.5	12.0	2.2	72										
to Ship Channel		Minimum	1.0	5.2	0	0	0.25	11.0	5.7	0.07	3									116	52
		No. of Samples	19	19	19	18	1	16	19	19	19								7	1	1
	2.5	Average	Median 43	7.1	15	0.016	-	19.5	10.2	0.33	9										
		Maximum	2,400	10.9	150	0.16	-	25.0	11.6	0.66	23										
		Minimum	3	5.0	0	0	-	11.0	8.7	0.08	5										
		No. of Samples	14	14	14	14	0	12	14	14	14								6		
	3.0	Average	Median 210	7	3.4	0.009	-	19.0	10.3	0.40	8										
		Maximum	1,100	10.6	30	0.12	-	24.5	11.9	0.87	15										
		Minimum	23	5.5	0	0	-	10.0	8.5	0.05	3										
		No. of Samples	14	14	14	14	0	12	14	14	14								6		
	4.0	Average	Median 240	6.9	5.8	0	-	18.5	10.1	0.31	8										
		Maximum	1100	11.8	45	0	-	24.5	11.8	0.57	18										
		Minimum	39	5.0	0	0	-	10.0	8.4	0.06	3										
		No. of Samples	14	14	14	14	0	12	14	14	14								6		

Table 20 — SUMMARY OF AVERAGE ANALYTICAL RESULTS — LAKE ST. CLAIR (continued)

Sampling Point & Location	Station (Miles)		Coliform MPN per 100 ml	Chlorides ppm	Phenols ppb	Ammonia as N ppm	[illegible] ppm	Temp. °C	D.O. ppm	BOD 5 day ppm	Turbidity ppm	pH	Alk. ppm	[illegible] ppm	[illegible]				Taste	Total Solids ppm	
															No.	[illegible]	No.	[illegible]		Total	[illegible]
	5.0	Average	Median 360	6.3	1.6	0.021	-	20.6	10.3	0.32	8										
		Maximum	>2,400	11.5	12	0.28	-	25.5	11.6	1.1	28										
		Minimum	43	3.8	0	0	-	11.0	8.8	0.08	3										
		No. of Samples	16	16	16	16	0	13	16	16	16										
																			6		
	6.0	Average	Median 230	6.8	8.1	0.017	-	20.6	10.3	0.36	8										
		Maximum	1100	11.0	60	0.24	-	24.5	11.7	0.80	48										
		Minimum	23	4.5	0	0	-	11.0	8.7	0.20	3										
		No. of Samples	16	16	16	16	0	13	16	16	16										
																			6		
	7.0	Average	Median 43	6.2	4.2	0.005	-	18.5	10.3	0.28	8										
		Maximum	460	9.9	46	0.08	-	23.5	11.6	0.70	27										
		Minimum	9.1	4.1	0	0	-	11.0	8.6	0.13	3										
		No. of Samples	15	16	16	16	0	13	16	16	16										
	8.0		For Point VI Refer to Range I - IV - VI.																6		
(S1-) - S - V	2.0 (S)	Average	Median 95	9.4	5.8	0.026	0.25	20.1	9.4	0.80	23										
Point Huron to		Maximum	26,000	23.0	25	0.24	0.25	27.5	12.0	2.2	75										
Mt. Clemens W.W. Intake		Minimum	1.0	5.3	0	0	0.25	11.0	5.7	0.07	3										
		No. of Samples	19	19	19	19	1	18	19	19	19									116	95
																				1	1
	2.5	Average	Median 130	9.7	3.5	0.028	0.20	20.0	9.4	0.73	16										
		Maximum	2,400	15.9	17	0.24	0.20	28.5	10.6	1.6	38										
		Minimum	2.5	6.2	0	0	0.20	11.0	0.11	4											
		No. of Samples	14	16	16	15	1	13	14	14	16									116	96
																			7	1	1
	3.0	Average	Median 95	10.7	6.75	0.026	0.30	20.0	9.6	0.96	18										
		Maximum	4,600	18.0	50	0.16	0.30	28.5	11.6	2.4	50										
		Minimum	9.1	5.8	0	0	0.30	11.0	8.5	0.10	4										
		No. of Samples	16	19	18	15	1	15	18	14	19									190	116
																			7	1	1
	3.5	Average	Median 140	10.6	9.1	0.028	0.30	20.5	8.7	0.95	18										
		Maximum	4,300	18.0	35	0.12	0.30	30.0	12.2	2.6	56										
		Minimum	<2.3	6.0	0	0	0.30	11.0	8.2	0.19	6									156	78
		No. of Samples	12	13	13	12	1	12	13	15	15										
																			7	1	1
	4.0	Average	Median 23	14.3	6.7	0.015	0.35	20.5	9.8	0.96	13										
		Maximum	1,100	60.0	40	0.08	0.35	29.5	11.4	1.6	28										
		Minimum	<3.6	5.6	0	0	0.35	11.0	8.4	0.36	4										
		No. of Samples	17	17	17	16	1	16	17	17	17									150	78
																			7	1	1
	4.5(N)	Average	Median 22	10.5	6.6	0.007	0.30	20.6	9.3	0.80	12										
		Maximum	980	30.0	60	0.04	0.30	29.5	11.2	2.2	38										
		Minimum	9.1	5.6	0	0	0.30	11.0	8.2	0.10	3										
		No. of Samples	17	17	17	16	1	16	17	17	17									164	[illegible]
																			7	1	
(N) - N - XI	5.5	Average	Median 43	6.2	0	0	-	12.6	10.2	0.42	14										
Point Huron to Mt. Clemens		Maximum	>2,400	6.8	0	0	-	15.5	10.6	0.51	16										
W. W Intake to St. Clair		Minimum	43	5.4	0	0	-	11.0	9.0	0.28	10										
Shores Light Buoy.		No. of Samples	3	3	3	3	0	3	3	3	3										
	6.5	Average	Median 43	6.6	0	0	-	12.5	10.05	0.39	19										
		Maximum	93	8.4	0	0	-	14.0	10.6	0.57	28										
		Minimum	7.3	5.6	0	0	-	11.0	9.5	0.30	13										
		No. of Samples	3	3	3	3	0	3	3	3	3										
	7.5	Average	Median 130	6.8	0	0	-	12.5	10.1	0.34	14										
		Maximum	150	7.3	0	0	-	14.0	10.6	0.46	16										
		Minimum	23	6.2	0	0	-	11.0	9.7	0.24	11										
		No. of Samples	3	3	3	3	0	3	3	3	3										

Table 20 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – LAKE ST. CLAIR (continued)

Sampling Point & Location	Station (Miles)		Coliforms MPN per 100 ml	Chlorides ppm	Phenols ppb	Amm. as N ppm	[illegible] ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm	Turbidity ppm	pH	Alk. ppm	Cl2 ppm	Threshold Odor, [illegible]				Taste	Total Solids ppm	
															No.	Nature	No.	Nature		Total	Volatile
	8.8	Average	Median 23	8.8	0	0	-	19.8	10.3	0.41	20										
		Maximum	45	7.8	0	0	-	18.5	10.8	0.56	30										
		Minimum	2.1	6.2	0	0	-	11.0	9.7	0.27	10										
		No. of Samples	3	3	3	3	-	3	3	3	3										
	9.8	Average	Median 33	8.8	0	0	-	20.0	10.05	0.27	11										
		Maximum	80	9.0	0	0	-	13.5	10.6	0.48	13										
		Minimum	2	7.0	0	0	-	11.0	9.8	0.21	9										
		No. of Samples	3	3	3	3	0	3	3	3	3										
(B) - V - XI	10.0(XI)	Average	Median 33	7.6	0	0	-	20.0	10.1	0.44	17										
Point Huron to Mt. Clemens		Maximum	60	10.0	0	0	-	13.0	10.8	0.84	27										
S.E. Islands to St. Clair		Minimum	2.1	5.8	0	0	-	11.0	9.7	0.30	10										
Light Buoy		No. of Samples	3	3	3	3	0	3	3	3	3										
		Average																			
		Maximum																			
		Minimum																			
		No. of Samples																			
		Average																			
		Maximum																			
		Minimum																			
		No. of Samples																			
		Average																			
		Maximum																			
		Minimum																			
		No. of Samples																			
		Average																			
		Maximum																			
		Minimum																			
		No. of Samples																			

Detroit River

Table 21 gives the summary of average analytical results for samples taken in the Detroit River. These results show a littoral stratification similar to that experienced in the St. Clair River. The pollution tends to hug the respective shores in the upper reaches of the stream. In the lower portion, below Fighting Island, there is a spreading and diffusion of the pollution across the width of the stream. This is well illustrated in the distribution of median coliform results graphically presented in figure 9.

Highest coliform values at the entrance to the Detroit River (range Dt-30.8w and Dt-30.7e) were found near both shores, the medians approximating 100 per 100 ml. At the boundary line this value was about 10. Conner Creek, which carries the storm overflow from part of the Detroit sewer system, had a median M.P.N. value of 460,000, and a maximum figure of 24,000,000. These high values are reflected in results obtained at range Dt-29.2w, a mile and a half downstream. Here, samples taken within 50 and 100 feet from shore gave median coliform results of 200,000 and 93,000 per 100 ml., respectively. The maximum rose to 1,100,000.

Moving downstream, the bacterial pollution continues to hug the respective shores, but the zones have widened by the time range Dt-20.6, above the Rouge River, is reached. The inflow of untreated sewage and combined sewer overflows from both sides of the river causes the median values at this range to rise to over 20,000 coliforms per 100 ml. on the United States side, and to just under 10,000 on the Canadian side.

Bacterial pollution from the Rouge River and the Detroit sewage treatment plant, as shown at range Dt-19.0, causes the coliform values to rise sharply near the United States shore to 93,000 M.P.N. per 100 ml. The flow of the river splits at Fighting Island, the float studies indicated a tendency for surface currents to travel from the mouth of the Rouge River and the vicinity of Zug Island across the boundary and into the channel on the Canadian side east of Fighting Island. In this channel the bacterial pollution is more uniformly distributed. It is likely influenced by the flow from Turkey Creek on the Canadian side and by material carried across the boundary.

The pollution west of Fighting Island is divided by Grassy Island, the more heavily concentrated flow staying close to the United States shore and entering Trenton Channel, west of Grosse Ile. The flow around both sides of Fighting Island combines east of Grosse Ile, and the pollution is fairly well distributed across the channel by the time range Dt-9.3e is reached. At range Dt-3.9, across the mouth of the Detroit River, the bacterial pollution on the Canadian side remained constant at about 5,000 M.P.N., but there is an increase on the United States side. This rise, with median values reaching 43,000 per 100 ml. at some of the sampling points, is caused by the polluted waters from Trenton Channel.

Comparisons of the bacterial loads of coliform organisms at specific points in the Lake Huron - Lake Erie section reveal significant effects of pollution increments and natural purification agencies. In approximate terms it may be stated that the load increases 200 times in passing through the St. Clair River. This then decreases to one-twentieth in passing through Lake St. Clair, and increases 300 times in passing through the Detroit River. The overall increase in coliform organisms from Lake Huron to Lake Erie is over 3,000 times.

Average phenol results for the Detroit River are contained in Figure 10. The effects of discharges from the industries and other sources on the United States side are clearly shown on this chart. Average phenol concentrations above the Rouge River generally varied from zero to 6 or 7 p.p.b. Individual results for each sampling point did not vary widely, except on one occasion. This occurred on range Dt-20.6 above the Rouge River. An individual result of 450 p.p.b. created a high average at the shore sampling point. On the Canadian side the average phenols were less than 11 p.p.b.

The first significant increase in phenol concentration occurred just below the Rouge River. Average values at shore points vary from 11 to 39 p.p.b. This rise may be attributed to discharges from the Rouge River and the Detroit sewage treatment plant. Samples taken at the mouth of the Rouge River had an average phenol concentration of 79 p.p.b. and a maximum of 260. The results on the Canadian side, at range Dt-17.0e, do not show any appreciable influence of phenols from the Rouge River and Detroit sewage treatment plant. There is an increase in phenols on the Canadian side at range Dt-9.3e which may be attributed to discharges from the waste beds on Fighting Island. At range Dt-17.4w the heavier concentrations appeared near the United States shore. This polluted zone continued downstream into the Trenton Channel, where additional phenol was added from Monguagon Creek and sources located along the Detroit River. At range Dt-3.9 the phenol concentration follows, in general, the same pattern as the coliform distribution, in that there is diffusion across the river, with a higher amount on the United States side due to the quantities added in the Trenton Channel area.

Biochemical oxygen demand results for sampling stations above the mouth of the Rouge River generally averaged less than 1 p.p.m. Below the Rouge River average results ranged up to about 4 p.p.m., with individual results up to 9 p.p.m. The average dissolved oxygen concentrations were generally above 8 p.p.m. Individual results as low as 4 or 5 p.p.m. were recorded at some of the sampling stations in the lower portions of the river.

Ammonia results generally followed the same distribution as the phenols. The waters above the Rouge River had very low concentrations while those below this tributary had a considerably higher ammonium content, especially near the United States shore. Average values in the lower reaches vary up to 0.41 p.p.m.

Turbidity results were somewhat higher than those found in the St. Clair River and Lake St. Clair. Results at a few locations were about 10 p.p.m. but the greater number of samples averaged between 15 and 20 p.p.m.

Alkalinity results were fairly constant, averaging about 80 p.p.m. The hydrogen-ion concentrations were also quite constant, varying between 7.5 and 8.0.

Oils were observed at a number of places in the Detroit River, but it was not feasible to determine the actual amounts by sampling. As in the St. Clair River objectionable conditions are created in many local areas by waste substances.

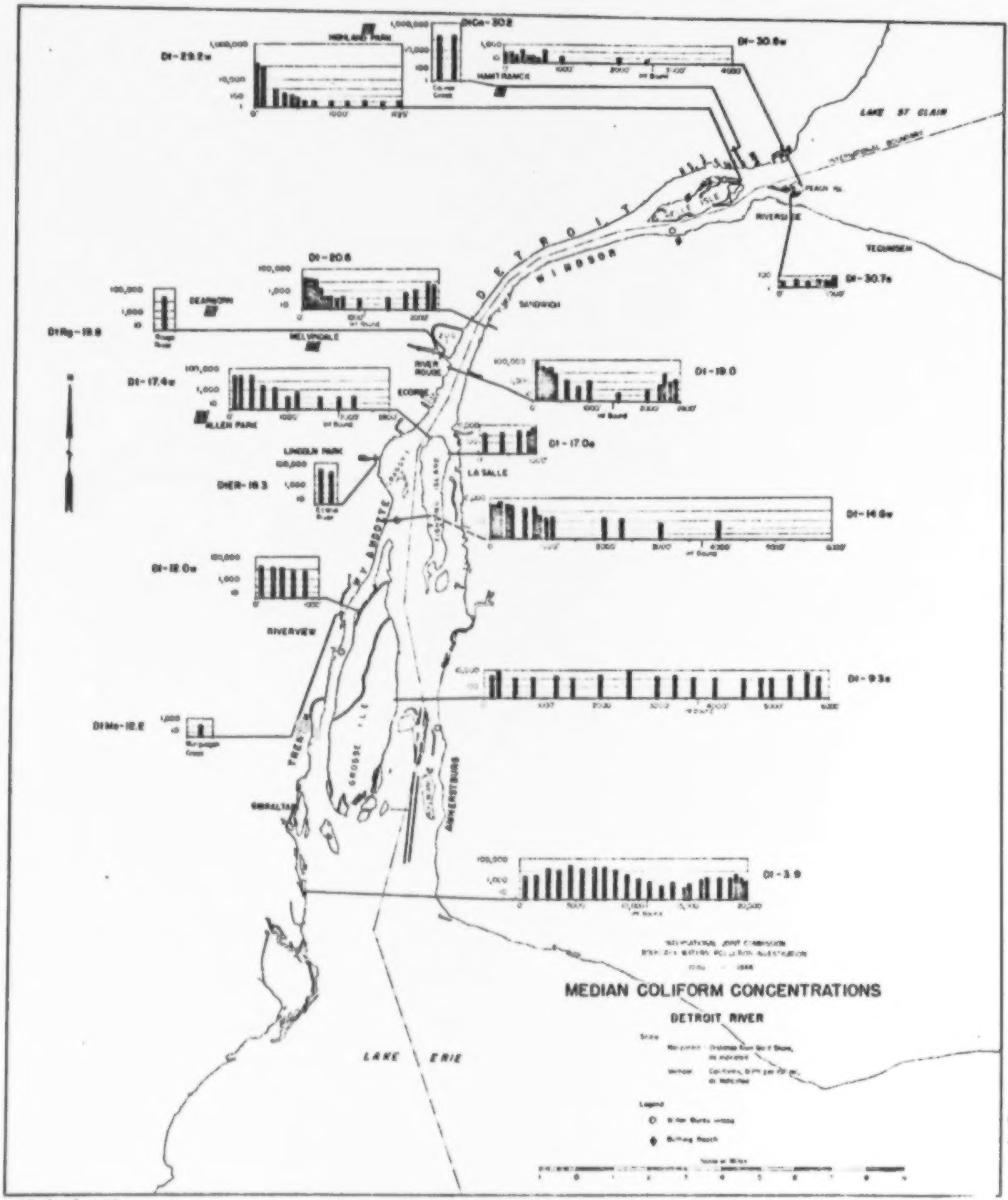
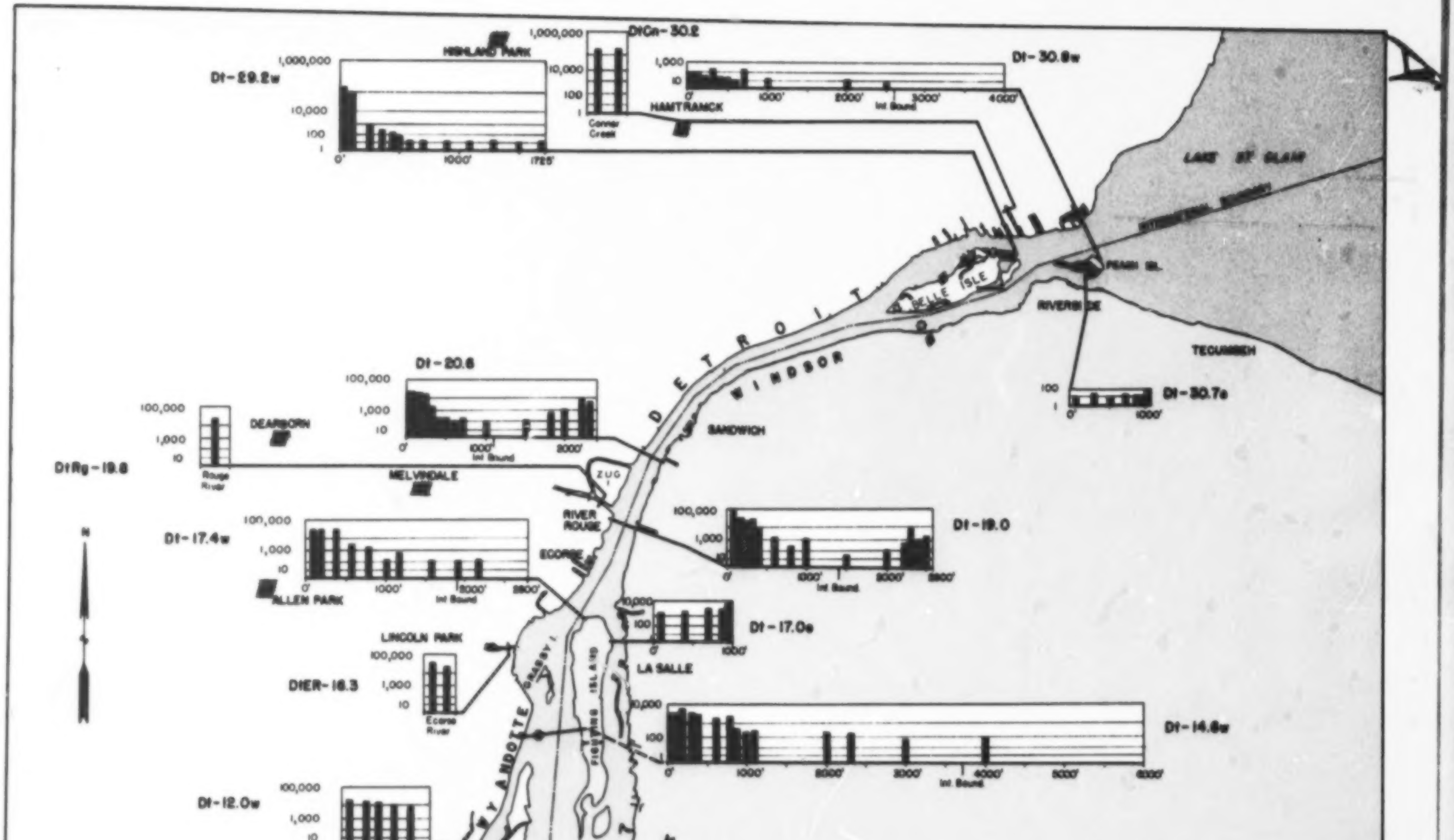
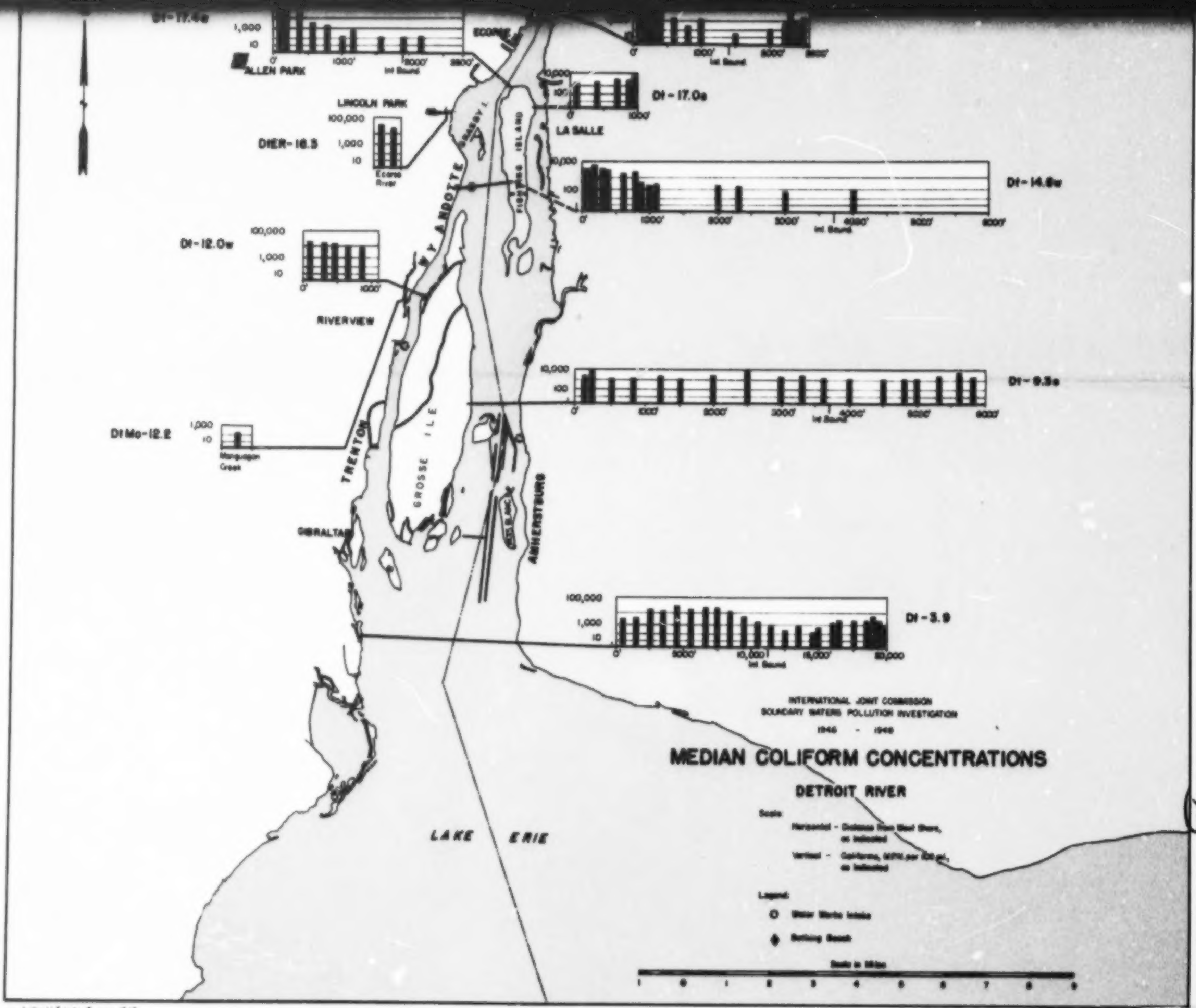

DI-29.2w
HIGHLAND PARK
1,000,000
10,000
100
1000
DI Co-30.2
Conners Creek
HAMTRAMCK
DI-30.8w
1000
2000
3000
4000
ft. Bound
LAKE ST. CLAIR
INTERNATIONAL BOUNDARY
PEACH IS.
BELLE ISLE
RIVERSIDE
TECUMSEH
DI-30.7e
DETROIT
WINDSOR
SANDWICH
DI-20.6
100,000
1,000
10
DEARBORN
DI Rg-19.8
Rouge River
MELVINDALE
RIVER ROUGE
DI-19.0
DI-17.4w
ECORSE
ALLEN PARK
DI-17.0e
LINCOLN PARK
DIER-16.3
Ecorse River
LA SALLE
DI-14.6w
FIGHTING ISLAND
WYANDOTTE
DI-12.0w
RIVERVIEW
DI-9.3e
DI Mo-12.2
Monguagon Creek
TRENTON
GROSSE ILE
GIBRALTAR
AMHERSTBURG
DI-3.9
0
5000
10,000
15,000
20,000
LAKE ERIE
INTERNATIONAL JOINT COMMISSION
BOUNDARY WATERS POLLUTION INVESTIGATION
1946 - 1948
MEDIAN COLIFORM CONCENTRATIONS
DETROIT RIVER
Scale
Horizontal - Distance from West Shore, as indicated
Vertical - Coliforms, MPN per 100 ml, as indicated
Legend
Water Works Intake
Bathing Beach
Scale in Miles
Base U.S. Lake Survey

Figure 14


A
LAKE ST CLAIR
INTERNATIONAL BOUNDARY
PEACH IS.
BELLE ISLE
RIVERSIDE
TECUMSEH
DETROIT
WINDSOR
SANDWICH
HIGHLAND PARK
HAMTRAMCK
DEARBORN
MELVINDALE
ZUG I.
RIVER ROUGE
ECORSE
ALLEN PARK
LINCOLN PARK
LA SALLE
GRASSY I.
FIGHTING ISLAND
WYANDOTTE
RIVERVIEW
TRENTON
GROSSE ILE
AMHERSTBURG
N
Dt-29.2w
1,000,000
10,000
100
1
0'
1000'
1725'
DtCn-30.2
Conner Creek
Dt-30.9w
1,000
10
4000'
Int Bound
Dt-30.7e
Dt-20.6
100,000
1,000
2000'
DtRg-19.8
Rouge River
Dt-19.0
2800'
Dt-17.4w
Dt-17.0e
DtER-16.3
Ecorse River
Dt-14.8w
6000'
Dt-12.0w
Dt-9.3e
DtMo-12.2
Monguagon Creek

131A



B
DI-17.4e
1,000
10
0'
1000'
2000'
Intl Bound
2800'
ALLEN PARK
ECORSE
DI-17.0e
10,000
100
1000'
LA SALLE
LINCOLN PARK
DIER-16.3
100,000
1,000
10
Ecorse River
WYANDOTTE
GRASSY I.
FIGHTING ISLAND
DI-14.6w
10,000
100
0'
1000'
2000'
3000'
4000'
Intl Bound
5000'
6000'
DI-12.0w
100,000
1,000
10
0'
1000'
RIVERVIEW
DI-9.3e
10,000
100
0'
1000'
2000'
3000'
Intl Bound
4000'
5000'
6000'
DI Mo-12.2
1,000
10
Monguagon Creek
TRENTON
GROSSE ILE
AMHERSTBURG
BOIS BLANC
GIBRALTAR
DI-3.9
100,000
1,000
10
0'
5000'
10,000'
Intl Bound
15,000'
20,000
INTERNATIONAL JOINT COMMISSION
BOUNDARY WATERS POLLUTION INVESTIGATION
1946 - 1948
MEDIAN COLIFORM CONCENTRATIONS
DETROIT RIVER
Scale:
Horizontal - Distance from West Shore, as Indicated
Vertical - Coliforms, MPN per 100 ml, as Indicated
Legend:
○ Water Works Intake
◆ Bathing Beach
LAKE ERIE
Scale in Miles
1 0 1 2 3 4 5 6 7 8 9

Litho U.S. Lake Survey 1949

Figure 9

(Follows page 132)

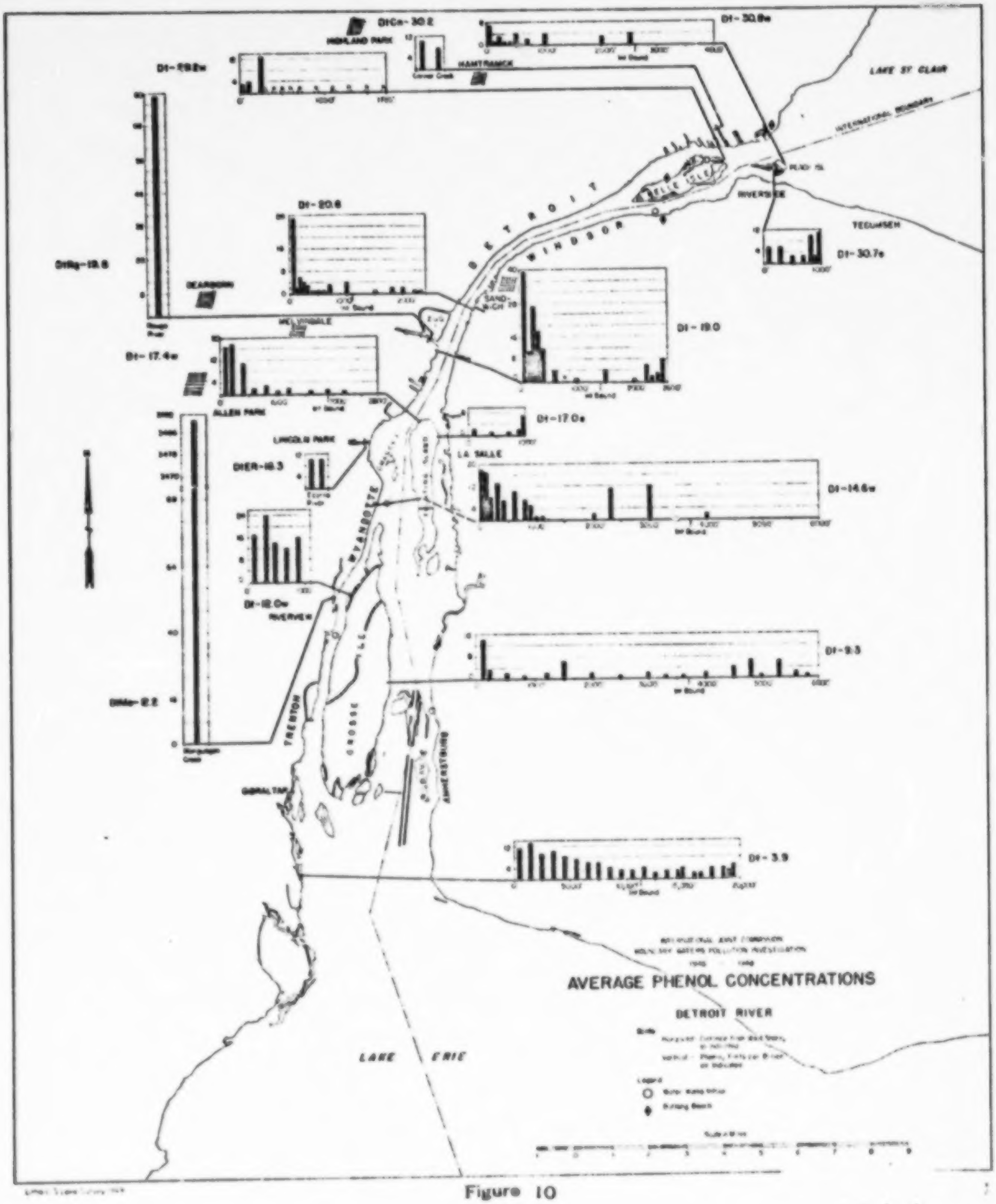
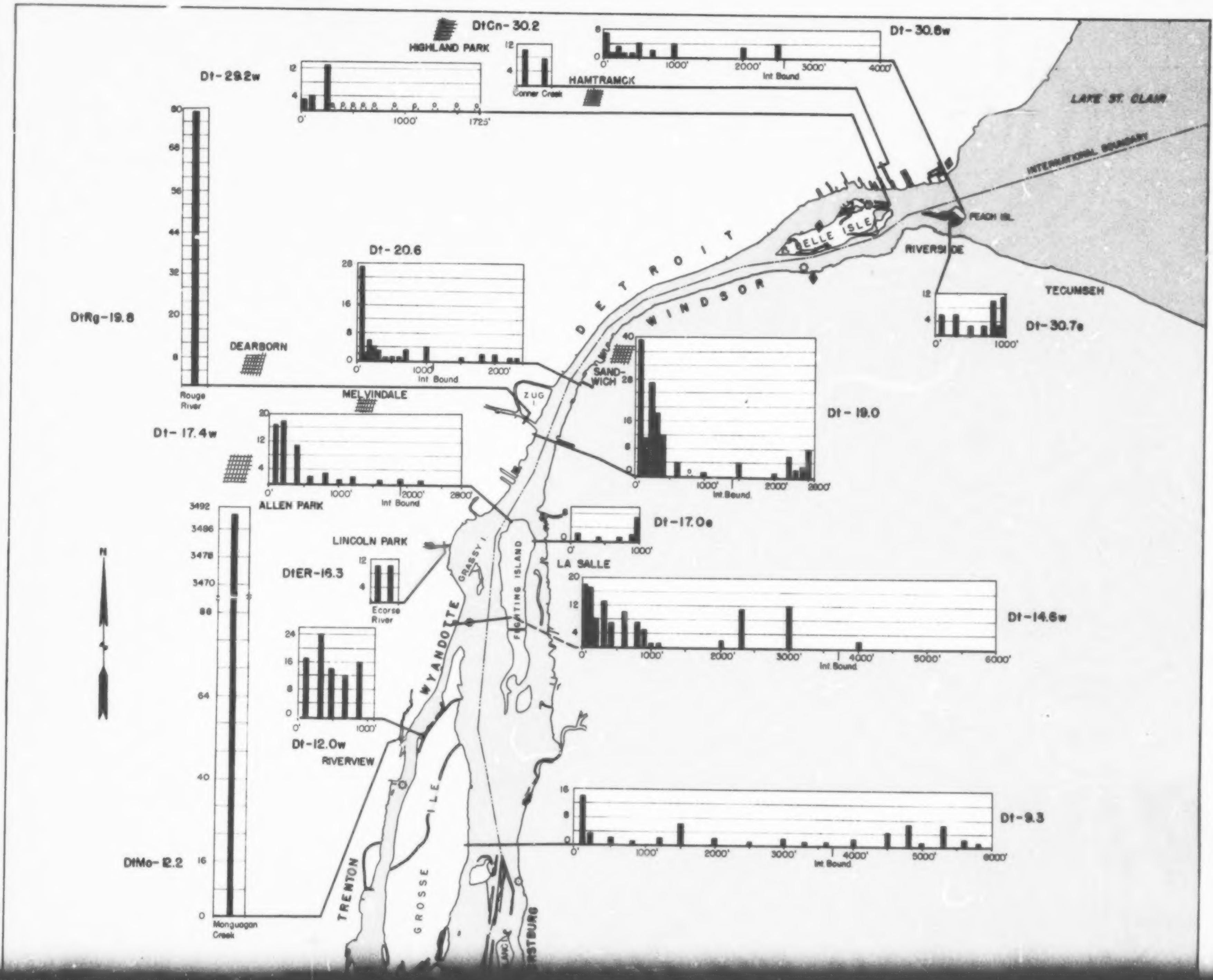
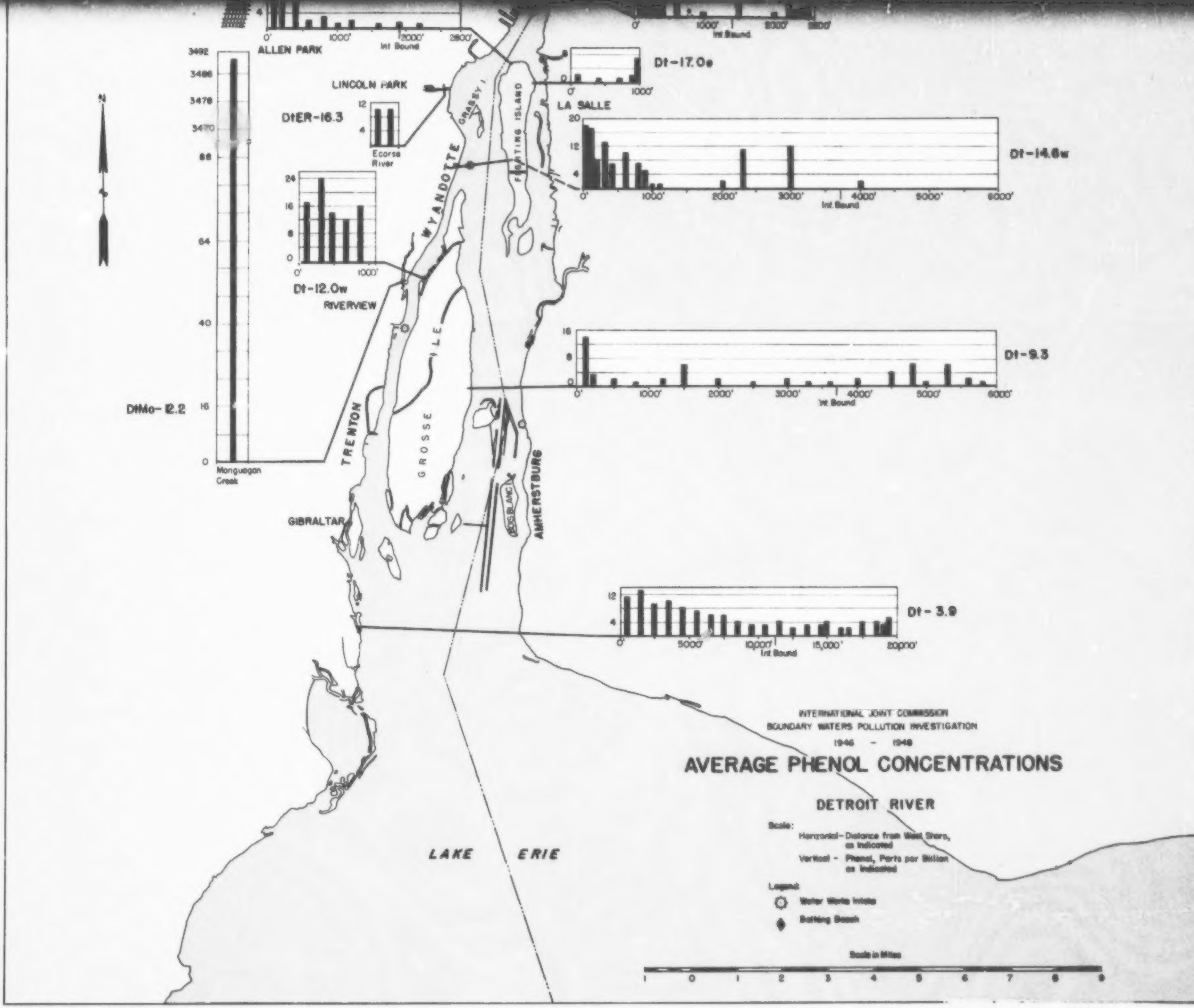

D1Cn-30.2
HIGHLAND PARK
HAMTRAMCK
Conner Creek
D1-30.8w
D1-29.2w
LAKE ST CLAIR
INTERNATIONAL BOUNDARY
PEACH IS.
BELLE ISLE
RIVERSIDE
TECUMSEH
D1-30.7e
DETROIT
WINDSOR
D1-20.6
D1Rg-19.8
DEARBORN
SANDWICH
D1-19.0
MELVINDALE
D1-17.4w
ALLEN PARK
D1-17.0e
LINCOLN PARK
LA SALLE
D1ER-16.3
D1-14.6w
WYANDOTTE
D1-12.0w
RIVERVIEW
D1-9.3
D1Mn-12.2
TRENTON
GROSSE ILE
AMHERSTBURG
GIBRALTAR
D1-3.9
AVERAGE PHENOL CONCENTRATIONS
DETROIT RIVER
Legend
LAKE ERIE

Figure 10

A


DtCn-30.2
HIGHLAND PARK
Dt-30.8w
12
4
Conner Creek
HAMTRAMCK
8
0
0'
1000'
2000'
3000'
4000'
Int Bound
Dt-29.2w
12
4
0'
1000'
1725'
LAKE ST. CLAIR
INTERNATIONAL BOUNDARY
PEACH ISL.
BELLE ISLE
RIVERSIDE
DETROIT
WINDSOR
TECUMSEH
Dt-30.7e
12
4
0'
1000'
80
68
56
44
32
20
8
Rouge River
DtRg-19.8
DEARBORN
Dt-20.6
28
16
8
0
0'
1000'
Int Bound
2000'
SANDWICH
Dt-19.0
40
28
16
8
0
0'
1000'
Int Bound
2000'
2800'
MELVINDALE
ZUG I.
Dt-17.4w
20
12
4
0'
1000'
2000'
2800'
Int Bound
ALLEN PARK
Dt-17.0e
0'
1000'
LA SALLE
3492
3486
3478
3470
88
64
40
16
0
Monguagan Creek
DtMo-12.2
LINCOLN PARK
DtER-16.3
12
4
Ecorse River
GRASSY I.
FIGHTING ISLAND
Dt-14.6w
20
12
4
0'
1000'
2000'
3000'
Int Bound
4000'
5000'
6000'
N
WYANDOTTE
Dt-12.0w
24
16
8
0
0'
1000'
RIVERVIEW
Dt-9.3
16
8
0
1000'
2000'
3000'
Int Bound
4000'
5000'
6000'
TRENTON
GROSSE ILE
RSTBURG

B 131B


ALLEN PARK
4
0'
1000'
2000'
2800'
Int Bound
DtMo-12.2
3492
3486
3478
3470
88
64
40
16
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Monguagon Creek
N
LINCOLN PARK
DtER-16.3
12
4
Ecorse River
Dt-12.0w
RIVERVIEW
24
16
8
0
0'
1000'
WYANDOTTE
GRASSY I.
FIGHTING ISLAND
TRENTON
GROSSE ILE
GIBRALTAR
BOIS BLANC I.
AMHERSTBURG
LA SALLE
Dt-17.0e
0'
1000'
Dt-14.6w
20
12
4
0'
1000'
2000'
3000'
4000'
Int Bound
5000'
6000'
Dt-9.3
16
8
0
0'
1000'
2000'
3000'
4000'
Int Bound
5000'
6000'
Dt-3.9
12
4
0'
5000'
10,000'
Int Bound
15,000'
20,000'
LAKE ERIE
Scale in Miles
1
0
1
2
3
4
5
6
7
8
9

INTERNATIONAL JOINT COMMISSION
BOUNDARY WATERS POLLUTION INVESTIGATION
1946 - 1948

AVERAGE PHENOL CONCENTRATIONS

DETROIT RIVER

Scale:
Horizontal - Distance from West Shore, as Indicated
Vertical - Phenol, Parts per Billion as Indicated

Legend:
○ Water Works Intake
◆ Bathing Beach

Litho U S Lake Survey 1949

Figure 10

([illegible] 132)

Table 21 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – DETROIT RIVER

Sampling Point	Mileage Index No.	Distance from West Shore		Coliforms MPN per 100ml	Chlorides ppm	Phenols ppb	Amm. as N ppm	Oxygen Dem. ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm	Turbidity ppm	pH	Alk. ppm	Oil ppm	Threshold Odor, Cold				Taste	Total Solids ppm	
																Raw		Chlorinated				
																No.	Nature	No.	Nature		Total	Volatile
							UNITED STATES SHORE															
Windmill Point to Head of Peach Island.	[illegible] W	0' 50'	Average	(Median) 64	7.6	7	0.02	0.33	13.0	9.5	0.79	20	7.9	81	0.3	2		1			130	75
			Maximum	>11,000	18	40	0.03	0.60	24.0	13.3	1.50	5	7.9	86	0.6	4		2			160	84
			Minimum	4.5	5.0	0	0	0.15	2.0	4.2	0.20	6	7.8	72	0	1		1			130	60
			No. of Samples	16	15	14	9	6	12	16	15	9	5	5	2	10		2		4	2	2
		100'	Average	(Median) 93	6.7	1	0	0.45	12.5	9.4	0.46		7.9	80		1				0		
			Maximum	240	8.1	2	0	0.45	15.5	11.4	0.74		7.9	84		1				0		
			Minimum	49	5.9	0	0	0.45	10.0	5.9	0.20		7.8	72		1				0		
			No. of Samples	5	5	3	1	1	5	5	4		4	4		4				1		
		200'	Average	(Median) 49	7.5	3	0.002	0.25	11.0	10.0	0.53	15	7.8	81	0.2	2		3			180	84
			Maximum	11,000	18	15	0.02	0.45	23.5	13.7	1.40	70	7.9	85	0.2	5		4			190	84
			Minimum	<2.3	5.4	0	0	0.15	2.0	5.8	0.00	4	7.8	60	0.2	1		2			190	84
			No. of Samples	15	14	12	9	3	12	14	13	8	5	5	1	7		2		2	1	1
		300'	Average	(Median) 180	6.2	1	0		13.0	8.5	0.25	35	7.8	79		1				0		
			Maximum	1,100	7.1	2	0		16.0	10.0	0.30	35	7.9	87		1				0		
			Minimum	11	4.8	0	0		11.0	5.7	0.20	35	7.7	68		0				0		
			No. of Samples	4	4	2	1		4	3	2	1	4	4		3				1		
		400'	Average	(Median) 69	6.2	1	0		12.5	9.4	0.39		7.9	78		1						
			Maximum	540	6.9	2	0		16.0	11.5	0.76		7.9	81		1						
			Minimum	3.0	5.0	0	0		9.5	5.7	0.10		7.8	69		0						
			No. of Samples	5	5	3	1		5	5	4		4	4		4						
		500'	Average	(Median) 31	6.9	4	0.001	0.28	12.5	9.9	0.66	13	7.8	78	0.5	1		1			140	74
			Maximum	900	11	15	0.01	0.60	24.0	13.9	1.8	35	7.9	83	0.8	2		3			190	64
			Minimum	2	4.8	0	0	0.10	2.0	5.8	0.20	2	7.8	71	0.1	0		1			130	84
			No. of Samples	17	15	14	9	6	12	16	15	9	5	5	2	9		3		3	2	2
		700'	Average	(Median) 130	5.9	2	0		12.5	9.3	0.32		7.9	77		1						
			Maximum	540	6.5	5	0		16.0	11.4	0.68		7.9	80		1						
			Minimum	23	5.4	0	0		9.5	5.8	0.1		7.8	70		0						
			No. of Samples	5	5	3	1		5	5	4		4	4		4						
		1000'	Average	(Median) 23	6.7	4	0.001	0.26	12.5	9.9	6.2	13	7.8	77	0.4	1		2		0	140	74
			Maximum	240	10	15	0.02	0.6	24.0	13.7	1.4	35	7.9	83	0.7	4		3.3		0	240	80
			Minimum	3.6	4.4	0	0	0.10	2.0	5.7	0.1	3	7.8	66	0.1	0		1		0	130	66
			No. of Samples	17	15	9	9	4	12	16	15	9	5	5	5	9		4		1	2	2
		2000'	Average	(Median) 11	6.8	3	0.002	0.21	11.0	9.9	0.67	14	7.8	78		1		2			130	64
			Maximum	130	13	10	0.08	0.50	18.0	13.5	1.70	35	7.9	83	0.6	3.3		3.3			130	68
			Minimum	<1.8	4.0	0	0	0.10	2.0	5.7	0.00	2	7.8	6'	0.2	0		1			130	60
			No. of Samples	17	15	14	9	5	12	16	15	9	5	5	2	9		4		3	2	2
		2500'	Average	(Median) 7.8	6.2	4	0.002	0.21	12.0	10.0	0.57	20	7.9	79	0.5	1		3			170	74
			Maximum	110	11	30	0.02	0.45	23.0	13.6	1.5	47	7.9	84	0.8	2		4			180	74
			Minimum	1.4	4.3	0	0	0.10	2.0	5.8	0.2	7	7.8	69	0.1	1		1			150	74
			No. of Samples	17	15	14	9	5	12	16	15	9	5	5	2	8		3		3	2	2
		2600'					INTERNATIONAL BOUNDARY															
		4500'					HEAD OF PEACH ISLAND															
							EAST SHORE PEACH ISLAND															
Peach Island to Canadian Shore at Head of Detroit River.	96-30.7 E	0' 100'	Average	(Median) 15	6.3	6	0.001	0.27	12.0	10.0	0.62	15	7.9	77	0.6	1		2			130	65
			Maximum	540	12	40	0.004	0.54	22.5	14.0	1.90	59	7.9	82	1.0	2		4			130	68
			Minimum	2	4.0	0	0	0.10	1.0	5.9	0.10	5	7.8	69	0.1	0		1			130	62
			No. of Samples	15	13	13	7	6	9	14	14	7	4	4	2	10		4		3	2	2
		300'	Average	(Median) 31	5.5	6	0	0.15	12.5	9.3	0.53	5	7.9	77	1.1	2		1			130	62
			Maximum	110	8.0	15	0	0.15	16.0	12.0	0.80	5	7.9	80	1.1	2		1			130	62
			Minimum	4.5	3.7	0	0	0.15	8.5	5.6	0.00	5	7.8	69	1.1	0		1			130	62
			No. of Samples	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]	[illegible]	[illegible]

Table 21 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – DETROIT RIVER (continued)

Sampling Point	Mileage Index No.	Distance from West Shore		Coliforms MPN per 100ml	Chlorides ppm	Phenols ppb	Amm. as N ppm	Chlor. Dem. ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm	Turbidity ppm	pH	Alk. ppm	Oils ppm	Threshold Odor, Cold				Taste	Total Solids ppm	
																Raw		Chlorinated				
																No.	Nature	No.	Nature		Total	Volatile
		500'	Average	(Median) 8	6.3	3	0.002	0.16	12.0	10.0	0.97	22	7.9	78	0.3	1		1			139	75
			Maximum	93	11	15	0.004	0.83	22.5	14.2	2.0	43	7.9	81	0.5	4		2			150	86
			Minimum	3	3.8	0	0	0.10	1.0	5.7	0	3	7.8	78	0	0		1			118	66
			No. of Samples	26	13	13	7	4	9	14	14	7	4	4	2	8		4		3	2	2
		700'	Average	(Median) 27	5.3	1			14.0	8.6	1.1		7.8	77		1						
			Maximum	46	5.9	5			16.0	10.1	2.0		7.9	80		1						
			Minimum	7.8	4.5	0			12.0	5.0	0.1		7.7	71		0						
			No. of Samples	3	3	2			2	3	2		3	3		3						
		850'	Average	(Median) 17	6.4	10	0.001	0.26	11.0	10.3	0.75	14	7.9	80	0.4	2		3				
			Maximum	190	10	80	0.004	0.60	22.5	14.1	2.0	54	7.9	80	0.7	3		4				
			Minimum	<1.8	3.8	0	0	0.10	1.0	7.0	0.2	3	7.9	80	0	1		1				
			No. of Samples	12	10	11	7	5	7	11	11	7	1	1	2	6		4		3		
Peach Island to Canadian	26-30.7	900'	Average	(Median) 17	5.1	3			14.0	8.7	0.2		7.9	77		1						
Shore at Head of Detroit			Maximum	190	5.8	5			16.0	10.3	0.3		8.0	84		1						
River. (Cont'd).			Minimum	13	5.1	0			12.5	6.0	0		7.8	70		0						
			No. of Samples	3	3	2			2	3	2		3	3		3						
		950'	Average	(Median) 79	6.4	11	0	0.32	12.0	9.9	0.56	16	7.9	77	0.6	1		2			140	67
			Maximum	2,400	13	40	0	0.70	22.0	14.2	1.4	59	8.0	82	1.1	3		2			140	76
			Minimum	1.8	3.5	0	0	0.10	2.0	5.8	0	8	7.8	68	0	0		0			130	58
			No. of Samples	15	13	11	7	5	9	14	14	7	3	3	2	8		3		3	2	2
		1000'						CANADIAN SHORE														
		0'						UNITED STATES SHORE														
[illegible] Boat Slip to	[illegible]	100'	Average	(Median) 150	6.9	5	0.009	0.32	14.5	9.4	0.40	24	7.9	83		1						
Peach Island Light.			Maximum	9,300	9.3	5	0.01	0.32	20.5	10.0	0.50	45	7.9	83		1						
			Minimum	91	5.3	5	0	0.32	11.5	8.8	0.29	11	7.8	82		1						
			No. of Samples	6	6	1	4	1	5	2	2	4	2	2		1						
		200'	Average	(Median) 70	6.7	0	0.001	0.32	14.0	9.9	0.57	20	7.9	80		1						
			Maximum	11,000	10	0	0.004	0.32	20.5	10.6	0.60	45	7.9	80		1						
			Minimum	< 23	5.0	0	0	0.32	11.5	9.2	0.53	8	7.9	80		1						
			No. of Samples	6	6	1	4	1	5	2	2	4	1	1		1						
		400'	Average	(Median) 130	6.8	0	0.001	0.30	14.0	9.6	0.41	19	7.9	79		1						
			Maximum	> 1,100	10	0	0.004	0.30	20.5	10.1	0.52	45	7.9	79		1						
			Minimum	< 23	4.8	0	0	0.30	11.5	9.1	0.30	8	7.9	79		1						
			No. of Samples	6	6	1	4	1	4	2	2	4	1	1		1						
		500'	Average	(Median) 150	6.9	0	0.001	0.30	14.0	9.6	0.37	19	7.9	79		1						
			Maximum	2,400	11	0	0.004	0.30	20.5	10.1	0.44	40	7.9	79		1						
			Minimum	< 23	5.0	0	0	0.30	11.0	9.1	0.30	8	7.9	79		1						
			No. of Samples	6	6	1	4	1	4	2	2	4	1	1		1						
		700'	Average	(Median) 230	6.5	0	0.001	0.31	14.0	9.6	0.38	20	7.9	79		1						
			Maximum	930	9.5	0	0.004	0.31	20.0	10.1	0.40	35	7.9	79		1						
			Minimum	< 23	4.6	0	0	0.31	11.0	9.1	0.36	8	7.9	79		1						
			No. of Samples	6	6	1	4	1	4	2	2	4	1	1		1						
		1000'	Average	(Median) 43	6.8	0	0.002		14.0	9.1	0.41	20										
			Maximum	1,100	9.7	0	0.08		20.0	9.1	0.41	35										
			Minimum	< 23	5.0	0	0		11.0	9.1	0.41	11										
			No. of Samples	5	5	1	4		4	1	1	4										
		1300'	Average	(Median) 36	6.9	0	0.001		14.0	9.0	0.36	22										
			Maximum	93	10	0	0.004		20.0	9.0	0.36	35										
			Minimum	< 23	5.2	0	0		10.5	9.0	0.36	13										
			No. of Samples	5	5	1	4		4	1	1	4										

Table 21 —SUMMARY OF AVERAGE ANALYTICAL RESULTS— DETROIT RIVER (continued)

Sampling Point	Mileage Index No.	Distance from West Shore		Coliforms MPN per 100 ml	Chlorides ppm	Phenols ppb	Amm. as N ppm	Chlor. Dem. ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm	Turbidity ppm	pH	Alk. ppm	Oils ppm	Threshold Odor, Cold				Taste	Total Solids ppm	
																Raw		Chlorinated			Total	Volatile
																No.	Nature	No.	Nature			
		2600'	Average	(Median) 36	6.5	0	0		14.0	9.0	0.38	20										
			Maximum	230	8.9	0	0		20.0	9.0	0.38	35										
			Minimum	9.1	5.8	0	0		10.5	9.0	0.38	18										
			No. of Samples	5	5	1	4		6	1	1	6										
[illegible] Boat Slip to Peach Island Light.(Cont'd).	[illegible]	2800'	Average	(Median) 23	6.6	0	0		14.5	9.0	0.33	11										
			Maximum	91	9.0	0	0		20.5	9.0	0.33	20										
			Minimum	< 23	5.3	0	0		10.5	9.0	0.32	0										
			No. of Samples	6	6	1	3		3	1	1	3										
		2700'	Average	(Median) 23	5.9	0	0		14.5	9.3	0.45	20	7.8	83								
			Maximum	36	6.3	0	0		20.5	9.3	0.45	35	7.8	83								
			Minimum	9.1	5.0	0	0		11.0	9.3	0.45	8	7.8	83								
			No. of Samples	5	5	1	4		4	1	1	4	1	1								
		3800' 4000'						INTERNATIONAL BOUNDARY CANADIAN SHORE														
Conner Creek at [illegible]	[illegible] 30.2	20'	Average	Median 240,000	33	10		1.38	5.0	7.28	29.4		7.4	180		6						
			Maximum	24,000,000	118	74		2.96	17.0	13.7	>84.5		7.7	220		66						
			Minimum	460	5.3	0		0.31	0	0	0		7.1	90		0						
			No. of Samples	36	23	20		23	24	23	23		23	23		23						
		40'	Average	Median 460,000	41	7.9		1.84	5.3	6.66	48.5		7.4	140		41						
			Maximum	15,000,000	110	74		9.07	17.0	13.7	331.5		7.9	230		296						
			Minimum	930	5.9	0		0.26	0	0	3.2		7.0	46		0						
			No. of Samples	36	32	30		32	33	30	32		32	32		32						
Detroit Edison Boat Slip to	24-29.2	0' 25'	Average	(Median) 200,000	8.7	3	0.78	UNITED STATES SHORE	16.0	2.8	>24.6	110	7.7	100								
Detroit Water Intake Near			Maximum	930,000	12	3	2.30		22.0	2.8	>24.6	>200	7.7	100								
Lagoon Light, Belle Isle.			Minimum	24,000	5.8	3	0.086		13.0	2.8	>24.6	23	7.7	100								
			No. of Samples	6	6	1	5		4	1	1	5	1	1								
		100'	Average	(Median) 93,000	8.1	4	0.96		15.0	7.8	3.4	91	7.8	88		1						
			Maximum	1,100,000	11	4	2.0		22.0	9.9	>5.6	195	7.9	96		1						
			Minimum	690	5.8	4	0		12.5	5.6	0.7	10	7.7	82		1						
			No. of Samples	7	7	1	5		5	2	2	5	2	2		1						
		250'	Average	(Median) 910	7.3	13	0.32		14.5	8.4	6.4	31	7.7	83		1						
			Maximum	240,000	10	13	1.5		21.0	10.1	0.6	65	7.7	83		1						
			Minimum	78	5.6	13	0		11.5	6.7	6.7	9	7.7	83		1						
			No. of Samples	7	7	1	5		5	2	2	5	1	1		1						
		300'	Average	(Median) 430	6.4	0	0.03	0.31	14.5	9.6	0.57	20	7.9	83		0						
			Maximum	15,000	7.0	0	0.06	0.31	20.5	10.1	0.6	45	7.9	85		0						
			Minimum	36	5.4	0	0	0.31	11.5	9.0	0.53	8	7.8	81		0						
			No. of Samples	7	6	1	4	1	5	2	2	4	2	2		1						
		400'	Average	(Median) 200	6.5	0	0	0.30	14.5	9.6	0.32	20	7.9	83		0						
			Maximum	4,300	8.7	0	0	0.30	20.5	10.0	0.33	45	7.9	85		0						
			Minimum	< 23	5.0	0	0	0.30	11.5	9.1	0.30	8	7.8	80		0						
			No. of Samples	7	7	1	5	1	5	2	2	5	2	2		1						
		500'	Average	(Median) 99	6.8	0	0		14.5	9.1	0.42	19	7.8	83								
			Maximum	4,300	9.5	0	0		20.0	9.1	0.42	37	7.8	83								
			Minimum	< 23	5.5	0	0		11.5	9.1	0.42	7	7.8	83								
			No. of Samples	6	6	1	5		3	1	1	5	1	1								
		600'	Average	(Median) 36	7.0	0	0	0.30	14.5	9.7	0.58	13	7.9	80		0						
			Maximum	240	9.0	0	0	0.30	20.0	10.2	0.70	20	7.9	80		0						
			Minimum	< 23	6.0	0	0	0.30	11.5	9.2	0.46	8	7.9	80		0						
			No. of Samples	6	6	8	3	1	4	2	2	4	1	1		1						

Table 21 —SUMMARY OF AVERAGE ANALYTICAL RESULTS— DETROIT RIVER (continued)

Sampling Point	Mileage Index No.	Distance from West Shore		Coliforms M.P.N. per 100ml	Chlorides ppm	Phenols ppb	Amm. as N ppm	Chlor. Dem. ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm	Turbidity ppm	pH	Alk. ppm	Oils ppm	Threshold Odor, Cold: Raw No.	Raw Nature	Chlorinated No.	Chlorinated Nature	Taste	Total Solids ppm Total	Total Solids ppm Volatile
		700'	Average	(Median) 36	6.8	0	0.004		14.0	9.2	0.56	17	7.8	84								
			Maximum	>1,100	9.8	0	0.02		20.0	9.2	0.56	35	7.8	84								
			Minimum	9.1	5.4	0	0		11.5	9.2	0.56	6	7.8	84								
			No. of Samples	6	6	1	5		4	1	1	5	1	1								
Detroit Edison Boat Slip to	Dt-29.2	900'	Average	(Median) 36	6.6	0	0		14.0	9.2	0.39	17	7.8	84								
Detroit Water Intake Boom			Maximum	>1,100	9.8	0	0		20.0	9.2	0.39	35	7.8	84								
Lagoon Light, Belle Isle.			Minimum	7.9	5.4	0	0		11.0	9.2	0.39	8	7.8	84								
(Cont'd).			No. of Samples	6	6	1	5		4	1	1	5	1	1								
		1100'	Average	(Median) 30	6.2	0	0.004		14.0	9.0	0.27	16	7.8	84								
			Maximum	>1,100	6.8	0	0.02		20.0	9.0	0.27	35	7.8	84								
			Minimum	7.3	6.0	0	0		10.5	9.0	0.27	7	7.8	84								
			No. of Samples	6	5	1	5		4	1	1	4	1	1								
		1300'	Average	(Median) 33	7.0	0	0		14.0	9.1	0.40	17	7.9	82								
			Maximum	< 460	14.5	0	0		20.0	9.1	0.40	35	7.9	82								
			Minimum	< 23	5.8	0	0		10.5	9.1	0.40	7	7.9	82								
			No. of Samples	6	6	1	5		4	1	1	5	1	1								
		1500'	Average	(Median) 23	6.6	0	0.002		14.0	9.1	0.51	22	8.0	86								
			Maximum	460	10	0	0.12		20.0	9.1	0.51	42	8.0	86								
			Minimum	23	5.5	0	0		10.5	9.1	0.51	8	8.0	86								
			No. of Samples	6	6	1	5		4	1	1	5	1	1								
		1700'	Average	(Median) 36	6.1	0	0.004		14.0	9.0	0.29	18	7.8	80								
			Maximum	< 230	10	0	0.02		20.5	9.0	0.29	36	7.8	80								
			Minimum	< 23	5.1	0	0		10.5	9.0	0.29	3	7.8	80								
			No. of Samples	6	6	1	5		4	1	1	5	1	1								
		1725'							WEST SHORE BELLE ISLE													
		1720'						PRESENT WATER INTAKE BOOM														
Between Present Detroit Water Intake Boom and Old Intake Structure. (400 feet downstream from present Intake).	Dt-29.2	1700'	Average	(Median) 380	7.0		0		11			16	7.8	83								
			Maximum	750	7.2		0		11			22	7.8	83								
			Minimum	9.1	6.8		0		11			10	7.8	83								
			No. of Samples	2	2		2		1			2	1	1								
(800 feet downstream from present Intake)	Dt-29.06	1600'	Average	(Median) 300	6.2		0		11			18	7.8	80								
			Maximum	750	6.4		0		11			22	7.8	80								
			Minimum	36	6.0		0		11			13	7.8	80								
			No. of Samples	2	2		2		1			2	1	1								
(1200 feet downstream from present Intake)	Dt-28.96	1500'	Average	(Median) 480	5.6		0		11			18	7.8	80								
			Maximum	930	6.6		0		11			22	7.8	80								
			Minimum	30	4.4		0		11			14	7.8	80								
			No. of Samples	2	2		2		1			2	1	1								
(1600 feet downstream from present Intake)	Dt-28.88	1500'	Average	(Median) 230	6.2		0		11			15	7.8	81								
			Maximum	430	7.2		0		11			22	7.8	81								
			Minimum	< 23	5.2		0		11			8	7.8	81								
			No. of Samples	2	2		2		1			2	1	1								
(2000 feet downstream from present Intake)	Dt-28.78	1400'	Average	(Median) 480	5.7		0		11			24	7.8	82								
			Maximum	930	6.3		0		11			35	7.8	82								
			Minimum	23	5.0		0		11			12	7.8	82								
			No. of Samples	2	2		2		1			2	1	1								
Between present Detroit Water Intake Boom and Old Intake Structure. (Cont'd). (2400 feet downstream from present Intake).	Dt-28.72	1300'	Average	(Median) 11,000	5.0		0		11			25	7.8	85								
			Maximum	11,000	5.0		0		11			25	7.8	85								
			Minimum	11,000	5.0		0		11			25	7.8	85								
			No. of Samples	1	1		1		1			1	1	1								

Table 21 —SUMMARY OF AVERAGE ANALYTICAL RESULTS— DETROIT RIVER (continued)

Sampling Point	Mileage Index No.	Distance from West Shore		Coliforms M.P.N. per 100 ml	Chlorides ppm	Phenols ppb	Amm. as N ppm	Chlor Dem ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm	Turbidity ppm	pH	Alk. ppm	Oils ppm	Threshold Odor, Cold				Taste	Total Solids ppm	
																Raw		Chlorinated				
																No.	Nature	No.	Nature		Total	Volatile
(3000 feet downstream from present intake).	24-26.4	1300'	Average	(Median) 5,500	5.6		0		11			13	7.8	88								
			Maximum	11,000	6.4		0		11			25	7.8	88								
			Minimum	43	4.8		0		11			11	7.8	88								
			No. of Samples	2	2		2		1			2	1	1								
(3000 feet downstream from present intake).			Average	(Median) 2,300	5.8		0.08		11			19	7.9	84								
			Maximum	4,600	6.8		0.08		11			25	7.9	84								
			Minimum	73	4.8		0		11			13	7.9	84								
			No. of Samples	2	2		2		1			2	1	1								
[illegible] Light Belle Isle across Canadian Channel normal to center line of stream.	24-25.2	0' 400'	Average	(Median 33	6.2	0	0	EAST SHORE OF BELLE ISLE, UNITED STATES	16.0	8.9	0.14	8										
			Maximum	43	6.2	0	0		21.0	8.9	0.14	8										
			Minimum	23	6.2	0	0		11.0	8.9	0.14	8										
			No. of Samples	2	2	1	1		2	1	1	1										
		1000'	Average	(Median) 89	6.2	5	0		16.0	9.0	0.47	8										
			Maximum	150	.4	5	0		21.0	9.6	0.47	8										
			Minimum	11	6.0	5	0		11.0	9.0	0.47	8										
			No. of Samples		2	1	1		2	1	1	1										
		1100'						INTERNATIONAL BOUNDARY														
		2000'	Average	(Median) 3,400	6.2	4	0		18.0	9.3	0.48	9										
			Maximum	4,300	6.6	4	0		22.0	9.3	0.48	9										
			Minimum	2,300	5.8	4	0		13.0	9.3	0.48	9										
			No. of Samples	2	2	1	1			1		1										
		2400'						CANADIAN SHORE														
Water Works Park Coal Dock to Detroit Yacht Club Dock, Belle Isle.	24-25.4	0' 100'	Average	(Median) 110,000	6.7		0.21	UNITED STATES SHORE	17.0			27										
			Maximum	240,000	7.0		0.26		22.0			36										
			Minimum	46,000	6.2		0.16		12.0			19										
			No. of Samples	3	3		2		2			2										
		200'	Average	(Median) 46,000	6.1		0.08		17.0			16										
			Maximum	110,000	6.6		0.10		21.0			18										
			Minimum	9,300	5.7		0.06		12.0			13										
			No. of Samples	3	3		2		2			2										
		300'	Average	(Median) 11,000	6.1		0.04		17.0			16										
			Maximum	93,000	6.4		0.04		21.0			27										
			Minimum	9,300	5.8		0.04		12.0			15										
			No. of Samples	3	3		2		2			2										
		400'	Average	(Median) 9,300	5.8		0					13										
			Maximum	15,000	6.6		0		20.5			14										
			Minimum	460	5.1		0		11.5			11										
			No. of Samples	3	3		2		2			2										
		700'	Average	(Median) 2,400	6.2		0		15.0			12										
			Maximum	> 24,000	7.0		0		20.0			12										
			Minimum	23	5.5		0		11.0			11										
			No. of Samples	3	3		2		2			2										
		1000'	Average	(Median) 43	6.7		0		15.0			13										
			Maximum	> 24,000	8.0		0		20.0			14										
			Minimum	23	3		0		11.0			12										
			No. of Samples	3	3		2		2			2										
		1300'	Average	(Median) 93	5.9		0		15.0			11										
			Maximum	460	7.2		0		20.0			14										
			Minimum	43	5.2		0		11.0			8										
			No. of Samples	3	3		2		2			2										

Table 21 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – DETROIT RIVER (continued)

Sampling Point	Mileage Index No.	Distance from West Shore		Coliforms M.P.N. per 100ml	Chlorides ppm	Phenols ppb	Amm. as N ppm	Chlor. Dem. ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm	Turbidity ppm	pH	Alk. ppm	Oils ppm	Threshold Odor, Cold				Taste	Total Solids ppm	
																Raw		Chlorinated				
																No.	Nature	No.	Nature		Total	Volatile
		1500'	Average	(Median) 23	3.7		0		14.0			11										
			Maximum	43	4.4		0		20.0			13										
			Minimum	14	4.0		0		11.0			8										
			No. of Samples	3	3		2		2			2										
		1900'						WEST SIDE OF BELLE ISLE														
U. S. Engineers Warehouse to Hiram Walker and Sons Ltd., Canada.	Dt 25.7	0' 50'	Average	(Median) 1,400	4.1	1	UNITED STATES SHORE, WEST SHORE DETROIT RIVER 0.05	0.66	2.0	13.2	2.1	12	7.6	80		2	Musty					
			Maximum	15,050	6.2	1	16	0.66	2.0	13.8	2.3	14	7.6	80		2	Musty					
			Minimum	1,900	2.2	0	0	0.66	2.0	12.3	2.0	9	7.6	80		2	Musty					
			No. of Samples	3	3	3	3	1	1	3	3	2	1	1		1						
		100'	Average	(Median) 1,600	6.6	2	0.05	0.53	2.0	13.3	1.5	15	7.6	80		2	Petrol					
			Maximum	5,400	7.1	5	0.16	0.53	2.0	13.9	2.2	20	7.6	80		2	Petrol					
			Minimum	430	6.0	0	0	0.53	2.0	12.4	0.8	9	7.6	80		2	Petrol					
			No. of Samples	3	3	3	3	1	1	3	2	2	1	1		1						
		300'	Average	(Median) 430	5.8	0	0.03	0.52	1.0	13.3	1.0	16	7.6	80		1	Musty					
			Maximum	2,400	7.5	0	0.08	0.52	1.0	13.9	1.5	23	7.6	80		1	Musty					
			Minimum	430	3.2	0	0	0.52	1.0	12.4	0.5	9	7.6	80		1	Musty					
			No. of Samples	3	3	3	3	1	1	3	3	2	1	1		1						
		600'	Average	(Median) 60	6.4	0	0.02	0.53	1.0	13.2	1.2	13	7.6	80		2	Petrol					
			Maximum	75	6.9	0	0.06	0.53	1.0	13.9	1.3	18	7.6	80		2	Petrol					
			Minimum	43	5.7	0	0	0.53	1.0	12.3	1.1	8	7.6	80		2	Petrol					
			No. of Samples	2	3	3	3	1	1	3	3	2	1	1		1						
		1000'	Average	(Median) 23	5.8	0	0.01	0.56	1.0	13.3	0.80	12	7.6	79		1	Petrol					
			Maximum	130	6.4	0	0.04	0.56	1.0	13.8	0.70	16	7.6	79		1	Petrol					
			Minimum	23	4.9	0	0	0.56	1.0	12.2	0.90	16	7.6	79		1	Petrol					
			No. of Samples	3	3	3	3	1	1	3	3	2	1	1		1						
		1900'						INTERNATIONAL BOUNDARY														
		2000'	Average	(Median) 43	5.9	0	0.01	0.56	1.0	13.2	0.83	12	7.6	80		1	Musty					
			Maximum	68	6.3	0	0.04	0.56	1.0	14.0	1.20	16	7.6	80		1	Musty					
			Minimum	7.3	5.2	0	0	0.56	1.0	12.0	0.37	8	7.6	80		1	Musty					
			No. of Samples	3	3	3	3	1	1	3	3	2	1	1		1						
		2600'	Average	(Median) 68	4.9	0	0.02	0.60	1.0	13.4	1.1	12	7.6	77		2	Petrol					
			Maximum	93	5.3	0	0.06	0.60	1.0	14.0	1.40	16	7.6	77		2	Petrol					
			Minimum	23	4.4	0	0	0.60	1.0	12.4	0.80	8	7.6	77		2	Petrol					
			No. of Samples	3	3	3	3	1	1	3	3	2	1	1		1						
		3000'	Average	(Median) 60	6.1	0	0		1.0	13.2	0.90	13										
			Maximum	93	6.3	0	0		1.0	14.1	1.30	13										
			Minimum	< 36	5.8	0	0		1.0	12.3	0.49	13										
			No. of Samples	2	2	2	2		1	2	2	2										
		3400'	Average	(Median) 170	5.9	0	0		2.0	13.3	0.66	13										
			Maximum	230	6.1	0	0		2.0	14.2	0.84	14										
			Minimum	93	5.7	0	0		2.0	12.4	0.47	12										
			No. of Samples	2	2	2	2		1	2	2	2										
		3490'						EAST SHORE, CANADA														
Foot of 12th Street across to Windsor Dock Company, Canada.	Dt-23.1	0' 100'	Average	(Median) 4,300	9.1	0	0	UNITED STATES SHORE -	7.0	10.6	0.91	20	7.8	83		1	Earthy					
			Maximum	14,000	13	0	0	-	12.0	13.9	1.90	32	7.8	83		1						
			Minimum	2,900	6.7	0	0	-	2.0	5.8	0.00	8	7.8	83		1						
			No. of Samples	3	3	2	2		2	3	3	2	1	1		1						
		200'	Average	(Median) 210	6.8	0	0		7.0	10.7	0.28	18	7.8	82		1	Earthy					
			Maximum	430	7.2	0	0		12.0	14.0	1.70	27	7.8	82		1						
			Minimum	78	6.5	0	0		2.0	5.8	0.00	8	7.8	82		1						
			No. of Samples	3	3	2	2		2	3	3	2	1	1		1						

Table 21 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – DETROIT RIVER (continued)

Sampling Point	Mileage Index No.	Distance from East Shore		Coliforms MPN per 100ml	Chlorides ppm	Phenols ppb	Ammonia as N ppm	Chlor. Dem. ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm	Turbidity ppm	pH	Alk. ppm	Oils ppm	Threshold Odor, Cold				Taste	Total Solids ppm	
																Raw		Chlorinated				
																No.	Nature	No.	Nature		Total	Volatile
Foot of 12th Street across to Windsor Salt Company, Canada. (Cont'd).	Dt-23.1	400'	Average	(Median) 130	6.6	0	0		7.0	10.7	0.94	14	7.8	81		0	0					
			Maximum	210	7.0	0	0		12.0	14.0	2.10	19	7.8	81		0						
			Minimum	93	6.1	0	0		1.0	5.8	0.80	9	7.8	81		0						
			No. of Samples	3	3	2	2		2	3	3	2	1	1		1						
		800'	Average	(Median) 93	5.7	0	0		7.0	10.7	0.66	16	7.8	80		0	0					
			Maximum	280	7.0	0	0		12.5	13.9	0	23	7.8	80		0						
			Minimum	43	4.7	0	0		1.0	5.9	0	8	7.8	80		0						
			No. of Samples	3	3	2	2		2	3	3	2	1	1		1						
		1000'							INTERNATIONAL BOUNDARY													
		1100'	Average	(Median) 93	5.6	0	0		7.0	10.5	0.55	11	7.9	81		0	0					
			Maximum	170	6.7	0	0		12.5	13.7	1.10	15	7.9	81		0						
			Minimum	9.1	4.4	0	0		1.0	5.7	0.00	7	7.9	81		0						
			No. of Samples	3	3	2	2		2	3	3	2	1	1		1						
		1700'	Average	(Median) 43	5.0	0	0		7.0	10.7	0.69	11	7.8	80		0	0					
			Maximum	240	5.7	0	0		12.5	14.0	0.76	17	7.8	80		0						
			Minimum	<18	4.1	0	0		1.0	5.8	0.00	5	7.8	80		0						
			No. of Samples	3	3	2	2		2	3	3	2	1	1		1						
		2100'	Average	(Median) 91	5.7	0	0		7.0	10.8	0.66	12	7.9	82		0	0					
			Maximum	490	6.9	0	0		13.0	14.1	1.10	15	7.9	82		0						
			Minimum	43	4.9	0	0		1.0	5.8	0.00	8	7.9	82		0						
			No. of Samples	3	3	2	2		2	3	3	2	1	1		1						
		2200'	Average	(Median) 1,900	5.4	0	0		7.0	10.7	0.63	15	7.9	81		1	Earthy					
			Maximum	24,000	6.1	0	0		13.0	14.0	1.20	18	7.9	81		1						
			Minimum	430	4.6	0	0		1.0	5.8	0.00	11	7.9	81		1						
			No. of Samples	3	3	2	2		2	3	3	2	1	1		1						
		2300'							EAST SHORE, CANADA													
Above Rouge River from Delray Detroit Edison Dock to Canadian Industries Ltd. Dock.	Dt-20.6	3' 5'	Average	(Median) 24,000	7.2	2			UNITED STATES SHORE 14.0	8.3	0.20		7.8	82		1.3						
			Maximum	54,000	7.8	7			16.0	9.8	0.40		7.8	83		2						
			Minimum	11,000	6.3	0			12.5	5.7	0		7.8	80		1						
			No. of Samples	3	3	3			3	3	2		3	3		3						
		20'	Average	(Median) 24,000	7.3	27	0.03	0.32	13.5	9.9	0.95	15	7.8	82	0	6		5			140	70
			Maximum	110,000	11	450	0.44	0.5	25.0	13.9	2.0	31	7.8	83	0	15		5			140	70
			Minimum	490	3.0	0	0	0.2	0	7.7	0.32	5	7.7	81	0	1		4			140	70
			No. of Samples	20	20	21	16	4	17	18	18	13	2	2	1	4		2			1	1
		50'	Average	(Median) 15,000	7.0	2			14.0	8.4	0.3		7.8	83		1						
			Maximum	35,000	7.6	5			16.0	10.0	0.5		7.8	87		1						
			Minimum	3,300	5.9	0			12.5	5.9	0		7.8	83		0						
			No. of Samples	3	3	3			3	3	2		3	3		3						
		100'	Average	(Median) 15,000	7.7	6	0.006	0.23	13.5	9.8	0.88	17	7.8	81	0.6	2		2			150	78
			Maximum	240,000	15	90	0.04	0.26	25.0	14.0	4.00	31	7.8	83	1.3	4		4			160	86
			Minimum	2,300	5.8	0	0	0.20	0	5.80	0	2.6	7.8	79	0	0		1			130	70
			No. of Samples	26	25	26	16	5	21	23	23	14	5	5	2	9		4		2	2	2
		200'	Average	(Median) 12,000	7.1	4	0.004	0.23	13.5	9.9	0.81	14	7.8	81	0.2	1		1			160	88
			Maximum	110,000	12	60	0.04	0.25	25.0	14.1	4.0	33	7.9	83	0.2	2		1			160	88
			Minimum	91	5.0	0	0	0.20	0	5.70	0	4	7.7	80	0.2	1		1			160	88
			No. of Samples	24	24	24	16	2	21	21	21	13	5	5	1	7		7		1	1	1
		300'	Average	(Median) 2,400	7.0	3	0.05	0.20	13.0	10.0	0.77	13	7.8	81	0.4	1		2			140	76
			Maximum	>24,000	12	25	0.50	0.31	24.5	14.0	3.60	32	7.8	83	0.7	3		4			190	90
			Minimum	91	4.8	0	0	0.15	0	5.7	0	3	7.8	80	0	0		1			130	62
			No. of Samples	26	25	26	16	4	21	23	23	14	5	5	2	9		4		2	2	2

Table 21 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – DETROIT RIVER (continued)

Sampling Point	Mileage Index No.	Distance from West Shore		Coliforms M.P.N. per 100 ml	Chlorides ppm	Phenols ppb	Ammonia as N ppm	Chlorine Demand ppm	Temp °C	D.O. ppm	B.O.D. 5 day ppm	Turbidity ppm	pH	Alk ppm	Oils ppm	Threshold Odor, Cold: Raw No.	Raw Nature	Chlorinated No.	Chlorinated Nature	Taste	Total Solids ppm: Total	Volatile
		400'	Average	(Median) 240	6.6	1	0	0.20	13.0	10.0	0.67	13	7.8	80	0	1		2			160	90
			Maximum	9,200	13	17	0	0.33	24.5	14.0	1.3	32	7.9	81	0	9		3			160	90
			Minimum	36	4.4	0	0	0.15	0	5.8	0	3	7.8	80	0	0		1			160	90
			No. of Samples	24	24	24	16	3	21	21	21	13	5	5	1	9		2		3	1	1
		500'	Average	(Median) 240	6.2	1	0.03	0.22	11.0	9.2	0.67	11	7.8	80	0.2	1		2			150	73
			Maximum	2,400	12	9	0.38	0.33	24.5	13.9	1.3	28	7.9	80	0.4	3		4			190	77
			Minimum	36	4.8	0	0	0.19	0	5.8	0.00	4	7.7	80	0	0		1			140	66
			No. of Samples	23	23	24	14	5	19	21	21	12	5	5	2	9		4		2	2	2
		600'	Average	(Median) 93	6.4	1	0.003	0.16	13.0	9.9	0.67	12	7.8	80	0.3	1		1			150	68
			Maximum	460	12	10	0.04	0.33	24.5	14.0	1.20	23	7.9	81	0.5	2		4			150	86
			Minimum	36	4.2	0	0	0.02	0	5.7	0.00	2	7.7	79	0	0		1			140	44
			No. of Samples	23	23	24	14	5	19	21	21	12	5	5	2	8		4		2	2	2
Above Rouge River from Delray Detroit Edison Dock to Canadian Industries Ltd. Dock. (Cont'd).	DR-20.6	700'	Average	(Median) 240	5.2	3	0.06	0.31	10.5	12.3	0.47		7.8	80		0						
			Maximum	240	5.7	8	0.06	0.31	15.5	12.4	0.85		7.9	80		0						
			Minimum	49	4.6	0	0.06	0.31	5.5	9.8	0		7.7	79		0						
			No. of Samples	7	7	7	1	1	7	7	6		5	5		4						
		1000'	Average	(Median) 93	6.2	4	0.006	0.20	13.0	10.0	0.56	14	7.8	79	0.7			1			150	79
			Maximum	750	12	40	0.08	0.30	24.5	14.2	1.8	25	7.9	80	1.1	3		2			190	88
			Minimum	15	4.2	0	0	0.1	0	5.78	0.00	3	7.6	78	0.2	0		1			140	70
			No. of Samples	23	23	24	14	5	19	21	21	12	5	5	2	8		4		2	2	2
		1100'							INTERNATIONAL BOUNDARY													
		1300'	Average	(Median) 180	6.3	1	0	0.18	13.0	9.9	0.58	13	7.8	79	0.4	2		1			140	70
			Maximum	5,400	12	12	0	0.32	24.5	14.3	1.30	23	7.8	81	0.8	3		1			140	74
			Minimum	23	4.3	0	0	0.1	0	5.8	0.16	3	7.8	78	0	0		1			140	60
			No. of Samples	24	21	23	13	5	18	21	21	12	5	5	2	8		3		2	2	2
		1800'	Average	(Median) 930	6.1	2	0.03	0.18	13.0	9.9	0.56	16	7.8	80	0.2	1		1			140	69
			Maximum	11,000	10	10	0.44	0.33	24.5	14.1	1.4	39	7.8	81	0.4	3		1			140	79
			Minimum	33	4.1	0	0	0.10	0	5.9	0	2	7.8	78	0	1		1			130	60
			No. of Samples	23	22	24	14	5	18	21	21	12	5	5	2	9		3		1	2	2
		2000'	Average	(Median) 2,400	6.0	2	0	0.19	13.5	9.9	0.84	17	7.7	81	0.5	1		1			130	72
			Maximum	24,000	11	10	0	0.31	24.5	14.3	4.80	42	7.8	83	0.9	3		1			150	76
			Minimum	230	4.1	0	0	0.1	0	5.8	0.00	2	7.4	80	0	1		1			110	66
			No. of Samples	24	22	24	14	5	18	21	21	12	5	5	2	9		3		2	2	2
		2200'	Average	(Median) 9,200	6.4	1	0.01	0.19	13.5	9.8	0.70	18	7.8	81	0.4	1		3			150	68
			Maximum	46,000	9.4	8	0.16	0.26	24.5	14.2	1.5	50	7.9	83	0.7	6.7		6.7			160	74
			Minimum	2,300	4.1	0	0	0.15	0	5.9	0	3	7.7	79	0	0		1			130	62
			No. of Samples	24	22	24	11	5	18	21	21	12	5	5	2	9		3		3	2	2
		2300'	Average	(Median) 8,200	8.9	1	0	0.17	13.5	9.8	1.25	18	7.8	81	0.1	1		1			160	[illegible]
			Maximum	43,000	15	10	0	0.26	24.5	14.2	1.60	43	7.9	82	0.3	2		1			170	61
			Minimum	1,100	5.5	0	0	0.1	0	5.8	0.00	2	7.7	80	0	1		1			150	76
			No. of Samples	23	22	24	14	5	18	21	21	12	5	5	2	9		3		2	2	2
		2400'							CANADIAN SHORE													
Rouge River (New Channel) at D.T.I. Railroad Bridge	DRR 19.3	70'	Average	Median 43,000	29	77	0.27	3.4	3.0	11.4	11.1	28	7.4	97		19						
			Maximum	930,000	76	260	1.1	3.7	16.0	13.7	22.1	68	8.2	120		64						
			Minimum	9,100	17	0	0.08	1.6	0	10.3	3.85	8	7.1	72		2						
			No. of Samples	22	24	25	25	4	25	23	23	20	24	23		19						
Below Rouge River from War Surplus Depot to Canadian Bridge Co., Ltd. East Slip.	DR-19.8	0'							UNITED STATES SHORE													
		100'	Average	(Median) 83,000	47	38	0.22	0.44	13.5	6.2	3.8	26	7.8	85	0.98	3.6		4.6			300	180
			Maximum	1,100,000	66	360	0.96	1.2	24.5	13.2	8.1	178	7.9	89	3.9	6.7		6.7			330	160
			Minimum	23,000	26	4	0	0.10	1.0	4.40	0.3	4.7	7.7	82	0	1		3			270	160
			No. of Samples	31	30	32	19	13	25	38	32	17	8	8	10	20		4		4	3	3

Table 21 —SUMMARY OF AVERAGE ANALYTICAL RESULTS— DETROIT RIVER (continued)

Sampling Point	Mileage Index No.	Distance from [illegible] Shore		Coliforms M.P.N. per 100 ml	Chlorides ppm	Phenols ppb	Amm. as N ppm	Chlor. Dem. ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm	Turbidity ppm	pH	Alk. ppm	Oils ppm	Threshold Odor, Cold: Raw No.	Raw Nature	Chlorinated No.	Chlorinated Nature	Taste	Total Solids ppm: Total	Volatile
		140'	Average	(Median) 54,000	15	11			14.0	5.75	2.7		7.8	83		1				-		
			Maximum	130,000	30	13			16.5	7.40	4.0		7.9	85		3						
			Minimum	14,000	10	10			12.5	4.35	0.6		7.7	80		1						
			No. of Samples	3	3	3			3	3	3		3	3		3						
		200'	Average	(Median) 39,000	18	27	0.41	0.70	8.5	9.1	4.3	8.3	7.8	84	0.5	1.7		1.5			240	[illegible]
			Maximum	460,000	50	80	0.56	1.1	16.5	12.3	9.2	13	7.9	87	0.7	4		2			—	
			Minimum	2,300	17	0	0.26	0.16	4.0	4.9	0.98	3.2	7.7	82	0.2	1		1			190	94
			No. of Samples	11	12	11	2	4	10	11	11	2	8	8	2	10		2		2	2	2
Below Rouge River from [illegible] Depot to Canadian Bridge Co. Ltd. Boat Slip. (Sheet 43)	[illegible]	300'	Average	(Median) 46,000	29	18	0.26	0.58	13.5	8.7	3.7	17	7.8	81	1.1	3.4		2			210	93
			Maximum	460,000	51	80	0.46	0.89	25.0	13.6	7.2	45	8.0	84	3.0	5		3			230	100
			Minimum	2,300	1.1	0	0	0.10	1	5.2	0.4	4.9	7.6	75	0	0		1			190	86
			No. of Samples	31	30	32	19	10	19	32	32	17	8	8	8	14		4		4	3	3
		400'	Average	(Median) 7,200	18	12	0.12	0.37	13.0	9.8	2.0	14	7.8	81	0.34	2		2			170	76
			Maximum	460,000	35	120	0.46	0.7	24.5	13.6	6.7	33	7.9	83	3.8	5		4			200	94
			Minimum	[illegible]	4.3	0	0	0	1.0	5.40	0	4.3	7.7	79	0	0		1		-	140	64
			No. of Samples	31	30	32	19	11	25	32	32	17	8	8	9	18		4		4	3	3
		600'	Average	(Median) [illegible]	13	4	0.02	0.26	13.0	9.8	1.2	14	7.9	80	0.8	1		1			150	67
			Maximum	240,000	29	20	[illegible]	0.55	24.5	13.9	5.5	41	8.0	82	2.8	3		2			170	78
			Minimum	73	[illegible]	0	[illegible]	0.1	0	5.50	0.1	2.7	7.8	79	0	0		1			140	62
			No. of Samples	30	30	32	19	10	25	32	32	17	8	8	5	14		4		4	3	3
		800'	Average	(Median) 500	7.7	0	0.01	0.22	10.0	10.2	1.16		7.9	81		0.3						
			Maximum	> 1,100	20	0	0.02	0.27	16.5	12.6	3.70		7.9	82		1						
			Minimum	23	4.5	0	0	0.14	5.5	5.60	0.05		7.8	79		0						
			No. of Samples	10	10	10	2	3	10	10	10		8	8		8						
		1000'	Average	(Median) 2,400	7.1	1	0.001	0.33	12.5	10.9	0.66	12	7.9	80	0.2	1.1		1			150	75
			Maximum	24,000	12	6	0.02	0.6	24.0	13.9	2.00	33	7.9	81	0.5	3		1			160	88
			Minimum	20	[illegible]	0		0.1	0	5.7	0	2.9	7.8	79	0	0		1			140	58
			No. of Samples	31	30	32	19	13	25	32	32	17	8	8	3	20		4		4	3	3
		1400'								INTERNATIONAL BOUNDARY												
		1900'	Average	(Median) 77	7.0	4	0.001	0.20	12.0	9.9	0.66	[illegible]	7.9	81	0.2	1.5		3			150	66
			Maximum	11,000	15	65	0.02	0.13	24.0	14.0	4.2	33	8.0	82	0.5	10		5			160	78
			Minimum	15	4.1	0	0	0.1	0	5.7	0	2.6	7.8	79	0	0		1			140	60
			No. of Samples	26	26	27	14	7	22	28	28	13	8	8	3	11		3		3	3	3
		2000'	Average	(Median) 330	5.5	1	0.02	0.38	10.0	10.3	0.9		7.8	80		0.1						
			Maximum	11,000	6.8	5	0.32	0.65	15.5	13.0	4.2		7.9	82		1						
			Minimum	15	4.3	0	0	0.21	5.0	5.6	0		7.7	78		0						
			No. of Samples	10	10	10	2	5	10	10	10		8	8		10						
		2200'	Average	(Median) 930	6.9	6	0.004	0.28	12.0	[illegible]	[illegible]	14	7.8	81	0.1	2		3			150	66
			Maximum	24,000	11	140	0.02	0.55	24.0	14.2	4.1	30	8.0	85	0.1	10		5			160	80
			Minimum	23	4.5	0	0	0.10	0	5.60	0	2.4	7.7	79	0	0		1			140	52
			No. of Samples	28	27	29	16	11	22	29	29	14	8	8	3	17		4		3	3	3
		2300'	Average	(Median) 11,000	6.7	2			13.5	7.0	1.0		8.0	83		0.7						
			Maximum	13,000	7.5	6			15.5	9.5	3.0		8.0	84		1						
			Minimum	9,200	5.4	0			12.5	5.6	0		7.9	81		0						
			No. of Samples	3	3	3			3	3	3		3	3		3						
		2400'	Average	(Median) 2,700	8.9	3	0.02	0.29	12.0	9.5	0.84	15	7.9	81	0.9	1		1			150	55
			Maximum	24,000	26	70	0.28	0.80	24.0	14.2	4.5	28	8.0	85	2.5	5		2			160	84
			Minimum	73	4.4	0	0	0.1	0	5.6	0	2.4	7.7	79	0	0		1			120	24
			No. of Samples	28	27	29	16	10	22	30	29	14	8	8	[illegible]	15		5		5	3	3

Table 21 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – DETROIT RIVER (continued)

[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Temp. °C	D.O. ppm	B.O.D. 5 day ppm	[illegible]	pH	Alk. ppm	[illegible]	[illegible]				[illegible]	[illegible]	
																[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	Average	(Median) 4,[illegible]	[illegible]	6	1	[illegible]	[illegible]	[illegible]	[illegible]	16	[illegible]	[illegible]	[illegible]	[illegible]		3			[illegible]	[illegible]
			Maximum	46,000	37	100	0.20	0.6	[illegible]	[illegible]	4.3	38	8.0	83	0.6	4.7		3			220	90
			Minimum	220	9.0	0	0	0.1	0	3.0	0	3.0	7.0	75	0	0		1			150	38
			No. of Samples	37	36	36	16	20	21	30	30	16	6	6	3	30		9		9	3	3
		2000'							[illegible]													
[illegible]	[illegible]	0' 200'	Average	(Median) 43,000	39	17	0.21	0.47	[illegible] 13.5	8.5	2.9	47	7.6	78	1.1	2.8		4			200	[illegible]
			Maximum	1,200,000	80	34	0.66	2.40	26.5	13.0	4.7	400	8.0	80	3.1	6.7		20.0			300	140
			Minimum	10,000	30	0	0.01	0.3	1.0	5.6	1.4	4.0	7.0	56	0	0		1			200	130
			No. of Samples	74	27	28	20	5	20	28	28	16	6	6	11	10		9		9	3	3
		200'	Average	(Median) 43,000	31	28	0.42	0.52	9.8	10.0	3.1		7.8	81		1						
			Maximum	170,000	41	69	0.26	0.44	14.5	13.0	5.6		8.0	85		3						
			Minimum	7,300	20	6	0.14	0.51	0.5	8.6	1.3		7.6	81		0						
			No. of Samples	9	9	9	3	2	9	8	8		6	6		6						
		400'	Average	(Median) 43,000	26	13	0.13	0.30	13.0	9.4	2.5	18	7.8	80	1.2	2.2		1.6			[illegible]	[illegible]
			Maximum	1,200,000	30	20	0.36	0.41	25.5	13.4	5.0	37	8.0	80	4.6	6.7		3			260	140
			Minimum	3,000	10	0	0	0.25	1.0	6.1	1.2	4.6	7.0	81	0	0		0			190	100
			No. of Samples	30	29	27	18	7	23	30	30	16	6	6	11	11		9		6	3	3
		600'	Average	(Median) 6,000	13	2	0.02	0.27	8.5	11.5	1.6		7.8	81	1.9	0.5						
			Maximum	46,000	21	0	0.08	0.29	14.0	13.2	3.8		8.0	83	1.9	1						
			Minimum	2,300	9.1	0	0	0.24	0.5	9.05	0.5		7.7	80	1.9	0						
			No. of Samples	9	9	9	3	3	9	8	8		6	6	1	6						
		800'	Average	(Median) 4,600	13	3	0.04	0.27	12.5	9.7	1.5	13	7.8	80	1.0	1.4		2			180	83
			Maximum	>2,400,000	37	20	0.36	0.31	25.0	13.7	7.8	34	7.9	80	2.9	5		4			280	110
			Minimum	330	5.6	0	0	0.8	0.0	2.0	0.6	4.5	7.6	79	0	0		1			160	64
			No. of Samples	30	27	28	18	7	23	28	28	16	6	6	10	11		4		4	3	3
		1000'	Average	(Median) 330	6.0	1	0.01	0.27	8.0	11.8	1.3		7.8	80		0.5						
			Maximum	4,600	7.2	5	0.02	0.31	14.0	13.2	4.6		7.9	80		1						
			Minimum	36	5.1	0	0	0.23	0.5	9.92	0.4		7.7	79		0						
			No. of Samples	9	9	9	3	3	9	8	8		6	6		6						
		1200'	Average	(Median) 920	7.8	2	0.005	0.27	12.5	10.7	0.84	12	7.8	79	0.8	1.6		1.3			150	67
			Maximum	240,000	16	13	0.06	0.40	24.5	13.0	4.6	28	8.0	81	1.7	6.7		2			170	
			Minimum	23	4.0	0	0	0.15	0	7.8	0.12	2.4	7.7	78	0	0		1			130	56
			No. of Samples	29	26	27	17	7	22	27	27	16	6	6	3	11		4		2	3	3
		1400'	Average	(Median) 580	4.6	0			13.5	9.9	4.5		7.9	80		0						
			Maximum	600	5.2	0			13.5	9.9	4.5		8.0	82		0						
			Minimum	560	4.0	0			13.0	9.9	4.5		7.8	78		0						
			No. of Samples	2	2	2			2	1	1		2	2		2						
		1600'	Average	(Median) 230	7.2	1	0.001	0.30	12.5	10.1	0.71	12	7.8	80	1.1	1		1			160	67
			Maximum	> 24,000	14	10	0.02	0.50	24.5	14.0	4.6	25	7.9	81	2.8	4		2			170	78
			Minimum	9.1	4.2	0	0	0.10	0	8.0	0.14	2.4	7.7	78	0	0		1			150	60
			No. of Samples	29	27	28	18	8	23	28	28	16	6	6	3	11		4		1	3	3
		1900'								INTERNATIONAL BOUNDARY												
		2000'	Average	(Median) 240	6.9	1.4	0.005	0.26	12.5	10.0	0.80	24	7.8	80	0.4	3.7		6.0			160	71
			Maximum	110,000	12	10	0.04	0.5	24.5	14.1	4.6	200	7.9	81	0.8	26.7		20.0			170	80
			Minimum	23	4.6	0	0	0.15	0	8.0	0.06	2.5	7.8	78	0	0		1			140	66
			No. of Samples	29	27	28	18	7	23	28	28	16	6	6	8	11		4		2	3	3
		2200'	Average	(Median) 350	6.5	1	0.02	0.24	12.4	10.2	0.77	18	7.8	80	0.1	1		1			160	71
			Maximum	4,600	10	12	0.14	0.4	24.5	14.2	6.7	120	7.9	83	0.4	3		2			160	82
			Minimum	33	4.3	0	0	0.1	0	7.8	0.1	2.7	7.8	78	0	0		1			160	60
			No. of Samples	29	27	28	18	7	23	28	28	16	6	6	3	10		4		2	3	3
		2400'							[illegible] SHORE OF FIGHTING ISLAND													

Table 21 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – DETROIT RIVER (continued)

Sampling Point	Mileage Index No.	Distance from Shore		Coliforms MPN per 100ml	Chlorides ppm	Phenols ppb	Ammonia as N ppm	[illegible] ppm	Temp. °C	D.O. ppm	BOD 5 day ppm	Turbidity ppm	pH	Alk. ppm	[illegible] ppm	Threshold Odor, Cold: [illegible] No.	Nature	[illegible] No.	Nature	Taste	[illegible] in ppm: Total	Volatile
								[illegible]														
[illegible]	[illegible]	100'	Average	(Median) 1,400	6.0	2	0.007	0.28	22.5	10.0	0.76	16	7.8	80	0.4	1.4		1.0			140	60
			Maximum	15,000	20	20	0.06	0.30	26.5	14.8	4.3	40	8.0	86	0.8	3		3			180	96
			Minimum	100	4.5	0	0	0.1	0	8.0	0.06	2.4	7.7	70	0	0		1			110	30
			No. of Samples	30	26	27	27	7	20	27	27	18	6	6	3	11	6	4		8	3	3
		400'	Average	(Median) 2,400	6.1	1	0.03		8.5	11.6	1.39		7.8	81		1						
			Maximum	4,600	8.8	5	0.04		16.0	13.6	4.6		8.0	86		3						
			Minimum	750	4.1	0	0		0.5	9.60	0.5		7.7	79		0						
			No. of Samples	9	9	9	3		9	8	8		6	6		6						
		700'	Average	(Median) 3,500	8.4	1	0.019		14.0	10.0	0.98	16	7.8	81	0.4	1.0		2			170	60
			Maximum	24,000	16	15	0.18	0.25	26.5	14.3	4.5	30	8.0	86	0.8	6.7		10			180	86
			Minimum	250	5.0	0	0	0.15	0	9.0	0.16	3.5	7.6	78	0	0		1			160	46
			No. of Samples	30	26	26	16	1	22	27	27	15	6	6	3	11		5		8	3	3
		900'	Average	(Median) 3,300	[illegible]	2	0.04		8.5	11.5	1.4		7.7	81		1						
			Maximum	[illegible],300	15	10	0.08		16.0	13.6	4.3		8.0	85		2						
			Minimum	2,000	[illegible]	0	0		0.5	9.4	0.97		7.6	79		0						
			No. of Samples	9	9	9	3	-	9	8	8		6	6		5						
		1000'	Average	(Median) 2,300	14	7	0.07	0.19	12.5	10.1	1.01	15	7.8	81	0.4	2.0		1			160	56
			Maximum	46,000	25	10	0.18	0.30	24.5	14.2	4.5	31	8.0	86	0.8	6.7		2			180	76
			Minimum	700	5.9	0	0	0.1	0	7.2	0.1	3.2	7.7	78	0	0		1			150	30
			No. of Samples	28	26	27	17	4	22	26	26	15	6	6	3	11		4			3	3
[illegible] River at Jefferson Avenue	[illegible] 16.3	20'	Average	Median 24,000	30	10		7.0		6.9	2.6		6.0	68		9						
			Maximum	46,000	33	20		13.7		7.3	3.0		7.2	80		16						
			Minimum	2,300	27	0		1.4		6.5	2.3		5.0	16		2						
			No. of Samples	2	2	2		2		2	2		2	2		2						
		40'	Average	Median 56,000	26	10		7.0		5.3	4.1		6.5	59		9						
			Maximum	110,000	36	20		11.0		7.3	6		7.3	81		16						
			Minimum	2,300	18	0		1.4		3.4	2.2		5.0	16		2						
			No. of Samples	2	2	2		2		2	2		2	2		2						
								UNITED STATES SHORE														
Southfield Road to Fighting Island North Lt. (In vicinity of dredge dumping area).	[illegible]	0' 200'	Average	9,300	36	10	0.28			7.0	2.60	21		83								
			Maximum	9,300	36	10	0.28			7.0	2.60	21		83								
			Minimum	9,300	36	10	0.28			7.0	2.60	21		83								
			No. of Samples	1	1	1	1			1	1	1		1								
		700'	Average	75,000	33	4	0.20		21.5	6.6	1.90	14										
			Maximum	75,000	33	4	0.20		21.5	6.6	1.90	14										
			Minimum	75,000	33	4	0.20		21.5	6.6	1.90	14										
			No. of Samples	1	1	1	1		1	1	1	1										
		1900'	Average	46,000	18	4	0.06		22.5	7.7	1.30	8				1.4						
			Maximum	46,000	18	4	0.06		22.5	7.7	1.30	8				1.4						
			Minimum	46,000	18	4	0.06		22.5	7.7	1.30	8				1.4						
			No. of Samples	1	1	1	1		1	1	1	1				1						
		3250'	Average	2,400	15	7	0		22.0	8.6	0.58	11										
			Maximum	2,400	15	7	0		22.0	8.6	0.58	11										
			Minimum	2,400	15	7	0		22.0	8.6	0.58	11										
			No. of Samples	1	1	1	1		1	1	1	1										
		3900'	Average	6,300	6.3	0	0		22.0	8.7	0.74	11				2.4					140	58
			Maximum	6,300	6.3	0	0		22.0	8.7	0.74	11				2.4					140	58
			Minimum	6,300	6.3	0	0		22.0	8.7	0.74	11				2.4					140	58
			No. of Samples	1	1	1	1		1	1	1	1				1					1	1

Table 21 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – DETROIT RIVER (continued)

Sampling Point	Mileage Index No.	Distance from Shore		Coliform MPN per 100 ml	Chlorides ppm	Phenols ppb	Ammonia as N ppm	Other Chem. ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm	Turbidity ppm	pH	Alk. ppm	Oils ppm	Threshold Odor, Cold: Raw No.	Raw Ratings	Chlorinated No.	Chlorinated Ratings	Taste	Total Solids ppm: Total	Volatile
		[illegible]	Average	2,400	6.0	0	0		20.0	8.8	0.37	0			3.6						130	60
			Maximum	2,400	6.0	0	0		20.0	8.8	0.37	0			3.6						130	60
			Minimum	2,400	6.0	0	0		20.0	8.8	0.37	0			3.6						130	60
			No. of Samples	1	1	1	1		1	1	1	1			1						1	1
		[illegible]	Average	2,300	9.7	5	0.004			9.6	0.79	14		80								
			Maximum	2,300	9.7	5	0.004			9.6	0.79	14		80								
			Minimum	2,300	9.7	5	0.004			9.6	0.79	14		80								
			No. of Samples	1	1	1	1			1	1	1		1								
		[illegible]	Average	2,400	7.4	4	0.006			6.5	0.40	15		80	3.6						200	139
			Maximum	2,400	7.4	5	0.006			6.5	0.42	15		80	3.6						200	139
			Minimum	2,400	7.4	4	0.006			6.5	0.40	15		80	3.6						200	139
			No. of Samples	1	1	1	1			1	1	1		1	1						1	1
		4800'							INTERNATIONAL BOUNDARY													
Southfield Road to Fighting Island North Lt. (In vicinity of dredge dumping area. [illegible]	96-16.0	4800'	Average	36	7.1	5	0			8.3	0.80	21		80								
			Maximum	36	7.1	5	0			8.3	0.80	21		80								
			Minimum	36	7.1	5	0			8.3	0.80	21		80								
			No. of Samples	1	1	1	1			1	1	1		1								
		4800'							WEST SHORE FIGHTING ISLAND													
Wyandotte Chemicals Salt Plant Intake across to Grassy Island Light.	96-15.6	0' 5'	Average	-	81	23	0.18		UNITED STATES SHORE 5.5	11.0	2.6	16	1									
			Maximum	-	173	25	0.20		6.0	11.6	2.9	25	1									
			Minimum	-	36	17	0.04		5.0	10.4	2.1	6	1									
			No. of Samples	-	4	4	4		3	4	4	4	1									
		20'	Average	(Median) 24,000	33	43	[illegible]		8.5	10.5	2.4	17	0.5									
			Maximum	43,000	46	[illegible]	[illegible]		17.5	11.6	[illegible]	28	0.5									
			Minimum	23,000	27	15	0.04		5.0	8.3	2.1	9	0.5									
			No. of Samples	5	5	5	[illegible]		4	[illegible]	5	5	1									
		100'	Average	(Median) 21,000	30	25	0.20		8.9	10.7	2.3	18	0.5									
			Maximum	93,000	99	52	0.72		17.5	[illegible]	2.9	33	0.4									
			Minimum	2,300	25	10	0.04		4.0	[illegible]	1.8	11	0.5									
			No. of Samples	5	5	5	5		4	5	5	[illegible]	1									
		200'	Average	(Median) 23,000	29	21	0.11		8.0	10.8	2.1	16										
			Maximum	43,000	35	[illegible]	0.24		17.0	11.9	3.0	26										
			Minimum	9,300	21	9	0.02		[illegible]	9.3	1.5	9										
			No. of Samples	5	5	[illegible]	5		[illegible]	5	5	5										
		400'	Average	(Median) 15,000	23	11	0.04		7.4	11.3	1.7	16										
			Maximum	46,000	28	28	0.08		16.5	14.3	2.3	27										
			Minimum	2,300	17	0	0		4.0	9.6	[illegible]	7										
			No. of Samples	5	5	5	5		4	5	5	5										
		700'	Average	(Median) 4,300	15	5	0.003		9.0	11.4	1.08	14										
			Maximum	24,000	21	13	0.014		17.0	11.1	1.60	26										
			Minimum	930	4.5	0	0		4.0	9.8	0.60	6										
			No. of Samples	5	5	5	5		4	5	5	5										
		1000'	Average	(Median) 9,300	12	5	0		8.0	11.7	0.95	13										
			Maximum	11,000	17	13	0		17.0	12.4	1.30	20										
			Minimum	430	8.4	0	0		4.0	10.5	0.88	8										
			No. of Samples	5	5	5	5		4	5	5	5										
		1950' 3000' 4800'							WEST SHORE GRASSY ISLAND INTERNATIONAL BOUNDARY WEST SHORE FIGHTING ISLAND UNITED STATES SHORE													
Wyandotte City Power Plant and Water Works Dock over Intake and through Out to Fighting Island.	96-14.6	0' 20'	Average	(Median) 43,000	57	20	0.39		11.0	10.0	2.3	18		80								
			Maximum	240,000	69	30	0.60		18.0	11.5	3.1	29		80								
			Minimum	9,300	36	10	0.06		5.0	8.4	1.8	11		80								
			No. of Samples	9	9	9	9		8	9	9	9		1								

Table 21 —SUMMARY OF AVERAGE ANALYTICAL RESULTS— DETROIT RIVER (continued)

Sampling Point	Mileage Index Mi.	Distance from West Shore		Coliforms MPN per 100 ml	Chlorides ppm	Phenols ppb	Amm. as N ppm	Chlor. Dem. ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm	Turbidity ppm	pH	Alk. ppm	Oils ppm	Threshold Odor, Cold				Taste	Total Solids ppm	
																Raw		Chlorinated				
																No.	Nature	No.	Nature		Total	Volatile
		100'	Average	(Median) 43,000	37	17	0.18		12.0	10.0	2.1	16										
			Maximum	160,000	58	30	0.44		23.5	11.6	2.6	33										
			Minimum	23,000	28	5	0.01		5.0	7.0	1.6	7										
			No. of Samples	10	10	10	10		9	10	10	10										
Wyandotte City Power Plant [illegible] intake and through Cut to Fighting Island. (Sect. 14).	DR-14.6	200'	Average	(Median) 70,000	35	8	0.14		16.0	9.1	1.8	11										
			Maximum	93,000	43	9	0.27		17.0	9.4	1.8	13										
			Minimum	43,000	28	7	0.004		15.0	8.8	1.7	8										
			No. of Samples	4	4	4	4		4	4	4	4										
		300'	Average	(Median) 43,000	28	13	0.10		11.0	10.4	1.9	15										
			Maximum	93,000	40	22	0.28		19.0	11.8	2.6	27										
			Minimum	23,000	23	5	0		4.0	8.9	1.3	8										
			No. of Samples	9	9	9	9		7	9	9	9										
		400'	Average	(Median) 33,000	26	7	0.06		16.0	9.3	1.7	13										
			Maximum	93,000	30	9	0.17		17.0	9.5	2.1	16										
			Minimum	24,000	23	5	0		15.5	9.2	1.4	8										
			No. of Samples	4	4	4	4		4	4	4	4										
		600'	Average	(Median) 19,000	24	10	0.04		10.5	10.6	1.7	15										
			Maximum	93,000	28	22	0.24		17.5	11.8	3.2	25										
			Minimum	3,900	18	4	0		4.0	9.2	1.0	9										
			No. of Samples	8	9	9	9		8	9	9	9										
		800'	Average	(Median) 24,000	21	7	0.01		10.0	10.8	1.3	13										
			Maximum	75,000	26	15	0.04		17.5	11.9	1.8	23										
			Minimum	910	10	2	0		4.0	9.2	0.8	8										
			No. of Samples	9	9	9	9		8	9	9	9										
		900'	Average	(Median) 4,300	15	5	0.004		11.5	10.5	1.6	12										
			Maximum	93,000	19	15	0.04		23.0	12.0	7.20	21										
			Minimum	930	8	0	0		5.0	8.4	0.43	7										
			No. of Samples	11	10	11	11		9	11	11	11										
		1000'	Average	(Median) 2,400	9.8	1	0		10.0	11.2	0.77	16										
			Maximum	15,000	14	5	0		16.0	12.2	1.30	37										
			Minimum	910	6.7	0	0		4.0	9.9	0.28	7										
			No. of Samples	9	9	9	9		8	9	9	9										
		1200'	Average	(Median) 3,100	8.6	1	0.002		14.0	10.5	0.68	10		82	1.5						180	120
			Maximum	43,000	13.0	15	0.02		23.0	12.2	1.60	32		82	1.5						180	120
			Minimum	230	6.0	0	0		5.0	8.6	0.26	7		82	1.5						180	120
			No. of Samples	22	22	22	22		20	22	22	22		1	1						1	1
		2000'	Average	(Median) 2,400	8.0	2	0		15.0	10.2	0.52	9										
			Maximum	4,600	10	5	0		16.0	10.3	0.62	11										
			Minimum	240	6.6	0	0		14.5	10.1	0.44	6										
			No. of Samples	3	3	3	3		3	3	3	3										
		2300'	Average	(Median) 1,380	6.5	11	0		22.5	8.6	0.56	11		82								
			Maximum	2,400	6.9	15	0		22.5	8.7	0.65	11		82								
			Minimum	230	6.1	6	0		22.5	8.5	0.46	10		82								
			No. of Samples	2	2	2	2		2	2	2	2		1								
		3000'	Average	(Median) 430	9.5	22	0		16.5	9.7	0.43	8			2.9						140	70
			Maximum	930	12	48	0		22.0	10.2	0.66	10			2.9						140	70
			Minimum	43	6.3	0	0		14.5	8.8	0.26	7			2.9						140	70
			No. of Samples	4	4	4	4		4	4	4	4			1						1	1

Table 21 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – DETROIT RIVER (continued)

Sampling Point	Mileage Index No.	Distance from West Shore		Coliforms M.P.N. per 100 ml	Chlorides ppm	Phenols ppb	Amm. as N ppm	Chlor. Dem. ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm	Turbidity ppm	pH	Alk. ppm	Oils ppm	Threshold Odor, Cold: Raw No.	Threshold Odor, Cold: Raw Maxima	Threshold Odor, Cold: Chlorinated No.	Threshold Odor, Cold: Chlorinated Maxima	* Taste	Total Solids ppm: Total	Total Solids ppm: Volatile
		3700' 4000'	Average	(Median) 939	5.5	2	0		INTERNATIONAL BOUNDARY 15.0	10.1	0.47	8										
			Maximum	2,400	6.7	5	0		16.0	10.2	0.48	10										
			Minimum	910	4.8	0	0		14.5	9.9	0.30	7										
			No. of Samples	3	3	3	3		3	3	3	3										
		6000'							WEST SHORE, FIGHTING ISLAND													
Trenton Channel Toll Bridge .200 United States Mainland shore to West Shore Grosse Ile.	Dt-12.8 W	0' 122'	Average	(Median) 22,000	50	17	0.06	0.41	UNITED STATES SHORE 7.0	10.7	2.3	13	7.8	86	0.3	2.7		3			240	140
			Maximum	240,000	85	56	2.40	0.90	24.5	14.6	4.7	29	8.2	94	0.8	16		6			270	150
			Minimum	4,300	26	0	0.00	0.20	0	4.9	0.0	4	7.4	80	0	1		1			210	110
			No. of Samples	44	37	38	23	14	39	40	39	23	23	22	3	20		4		2	3	3
		302'	Average	(Median) 20,000	34	24		1.28	9.0	9.6	2.1		7.8	84		1						
			Maximum	110,000	48	160		4.47	18.5	14.7	3.6		7.9	98		2						
			Minimum	3,900	30	0		0.41	0	5.0	0		7.4	79		1						
			No. of Samples	12	11	10		5	12	10	9		11	11		10						
		490'	Average	(Median) 17,000	28	14	0.16	0.80	6.5	12.4	2.1	14	7.7	85	0.4	2.2		1				
			Maximum	460,000	44	50	0.85	9.42	24.0	14.8	4.0	32	7.9	93	0.7	16		2				
			Minimum	2,300	18	0	0.00	0.20	0	5.2	0.0	4	7.2	74	0	0		1				
			No. of Samples	43	37	38	24	13	38	39	38	24	22	21	3	21		4		2		
		670'	Average	(Median) 9,300	20	12		0.41	8.0	10.2	1.6		7.8	84		1						
			Maximum	54,000	30	70		0.76	18.5	15.0	3.3		7.9	90		4						
			Minimum	4,300	17	0		0.30	0	5.4	0.0		7.5	82		0						
			No. of Samples	12	11	10		6	12	11	10		11	11		10						
		880'	Average	(Median) 9,300	21	16	0.12	0.38	6.6	10.6	1.8	12	7.7	83	0.1	1		1				
			Maximum	1,100,000	32	130	1.36	1.10	23.5	14.0	3.5	23	7.9	92	0.7	8		2				
			Minimum	2,300	12	0	0	0.20	0	5.4	0.0	3	7.3	72	0.0	0		1				
			No. of Samples	43	37	38	22	12	38	38	36	22	22	21	3	21		4		2		
		1100'							WEST SHORE GROSSE ILE													
Monguagon Creek at Biddle Street	DtMo 12.2		Average	Median 220	300	1400	7.8		8.6	5.1	98	27	9.4	150		1,920						
			Maximum	2,300	400	17,500	20.0		15.0	10.1	>280	54	9.6	220		8,200						
			Minimum	14	130	45	0.5		3.0	0.1	15.9	14	8.9	120		512						
			No. of Samples	10	10	10	10		10	10	10	10	10	10		10						
Grosse Ile to Canadian Shore above Stony Island.	Dt- 9.3 E	0' 100	Average	(Median) 4,900	24	14	0.013	0.25	EAST SHORE GROSSE ILE 11.5	9.6	1.6	12	8.0	80	0.2	2.7		1.7			160	73
			Maximum	92,000	28	190	0.04	0.4	24.5	11.9	3.2	46	8.0	80	0.5	6.7		5			180	94
			Minimum	2,300	13	0	0	0.1	2.0	7.4	0.40	1.6	8.0	80	0	0		1			140	58
			No. of Samples	14	13	14	7	6	8	14	14	10	1	1	3	7		6		4	5	5
		200'	Average	(Median) 9,200	20	3	0.003	0.13	11.5	9.5	1.9	11	7.9	80	0.4	2.4		2			160	79
			Maximum	110,000	25	15	0.02	0.20	24.5	12.0	9.4	32	7.9	80	0.9	6.7		5			190	96
			Minimum	2,100	13	0	0	0.05	2.0	7.8	0.65	0.7	7.9	80	0	0		1			130	70
			No. of Samples	14	13	14	7	6	8	14	14	10	1	1	3	1		6	1		5	5
		500'	Average	(Median) 2,600	18	2	0.02	0.20	13.0	9.6	1.2	11	8.0	78		2		1			160	52
			Maximum	35,000	36	9	0.06	0.30	24.5	12.0	2.3	21	8.0	78		3		1			170	62
			Minimum	490	13	0	0	0.10	2.0	6.3	0.48	0.6	8.0	78		0		1			140	48
			No. of Samples	11	11	12	8	6	9	12	11	8	1	1		4		3		3	[illegible]	2
		800'	Average	(Median) 2,900	17	1	0.01		11.0	9.9	1.3		7.7	71		0	0					
			Maximum	4,300	18	2	0.02		14.0	11.8	2.2		7.7	71		0						
			Minimum	1,900	16	0	0		9.0	6.1	0.3		7.7	71		0						
			No. of Samples	2	3	3	2		3	3	3		1	1		1						
		1200'	Average	(Median) 3,900	18	2	0.004	0.11	11.5	9.5	1.5	8	8.0	80	1.4	2		2.5			160	76
			Maximum	54,000	36	8	0.02	0.16	24.5	12.0	5.0	18	8.0	80	5	4		5			190	94
			Minimum	390	12	0	0	0	2.0	6.1	0.4	0.8	8.0	80	0	0		1			130	60
			No. of Samples	14	13	14	5	9	8	14	14	20	1	1	6	4		6		3	5	5

Table 21 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – DETROIT RIVER (continued)

Sampling Point	Mileage Index No.	Distance from [illegible] Shore		Coliforms MPN per 100 ml	Chlorides ppm	Phenols ppb	Ammonia as N ppm	Chlorine Demand ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm	Turbidity ppm	pH	Alk. ppm	Oils ppm	Threshold Odor, Cold				Taste	Total Solids ppm	
																Raw		Chlorinated				
																No.	Nature	No.	Nature		Total	Volatile
		1500'	Average	(Median) 1,500	23	6	0.02		10.5	9.8	1.1		8.0	84		0						
			Maximum	4,300	26	16	0.04		9.0	11.8	1.5		8.0	84		0						
			Minimum	490	10	0	0		8.5	5.8	0.4		8.0	84		0						
			No. of Samples	3	3	3	2		3	3	3		1	1		1						
		2000'	Average	(Median) 1,800	15	2	0	0.14	11.5	9.2	1.2	7	7.8	81	0.07	1.6		2			160	78
			Maximum	>24,000	23	6	0	0.20	24.5	12.1	4.0	16	7.8	81	0.2	4		5			180	110
			Minimum	790	11	0	0	0.1	2.0	5.6	0.3	1.3	7.8	81	0	0		1			140	59
			No. of Samples	14	13	14	7	7	8	14	14	10	1	1	3	7		6		3	5	5
		2500'	Average	(Median) 9,300	11	1	0.01		10.5	9.7	0.75		7.9	80		0						
			Maximum	13,000	25	2	0.02		13.5	11.8	1.3		7.9	80		0						
			Minimum	2,400	6.4	0	0		8.5	5.5	0.3		7.9	80		0						
			No. of Samples	3	3	3	2		3	3	3		1	1		1						
Grosse Ile to Canadian Shore above Stony Island. (Cont'd).	29- 9.3	3000'	Average	(Median) 3,000	12	2	0	0.12	11.5	9.3	1.8	9	7.9	80	0.3	1.7		1.1			170	82
			Maximum	13,000	22	6	0	0.20	25.0	12.1	7.8	23	7.9	82	0.4	4		2			180	96
			Minimum	430	3.2	0	0	0.1	2.0	5.5	0.2	1.6	7.9	82	0	0		1			150	52
			No. of Samples	14	22	14	7	7	8	14	14	9	1	1	3	7		6		3	4	4
		3300'	Average	(Median) 4,000	17	1	0.002	0.17	11.5	9.7	0.66	8	7.9	80		3		1			190	76
			Maximum	17,000	23	4	0.006	0.2	25.0	12.1	1.0	20	7.9	80		5		1			170	88
			Minimum	930	3.7	0	0	0.1	2.0	5.5	0.2	0.5	7.9	80		0		1			130	70
			No. of Samples	11	10	11	7	3	8	11	10	7	1	1		4		3		3	2	2
		3600'	Average	(Median) 2,400	10	1	0	0.17	11.4	9.7	0.61	11	7.9	81		1.8		1			150	83
			Maximum	> 24,000	23	5	0	0.2	25.0	12.1	1.6	19	7.9	81		5		1			160	92
			Minimum	91	4.5	0	0	0.1	2.0	5.6	0.30	0.6	7.9	81		0		1			130	74
			No. of Samples	11	10	11	7	3	8	11	11	6	1	1		4		3		3	2	2
		3700'								INTERNATIONAL BOUNDARY												
		4000'	Average	(Median) 1,300	8.6	2	0.05	0.13	11.0	9.2	0.35	8	7.8	81	1.2	1.7		1.7			150	74
			Maximum	16,000	11.0	70	0.32	0.2	25.0	12.3	1.0	21	7.8	81	1.7	3		5			170	92
			Minimum	23	1.9	0	0	0.1	2.0	5.7	0	1.1	7.8	81	0.5	0		1			120	50
			No. of Samples	14	13	14	7	7	8	14	13	10	1	1	3	7		6		3	5	5
		4500'	Average	(Median) 1,100	10	4	0	0.14	11.0	9.5	0.87	10	7.9	82	1.1	2.2		2.2			140	65
			Maximum	24,000	19	6	0	0.2	25.0	12.2	3.6	26	7.9	82	2.7	6.7		5			170	70
			Minimum	91	1.0	0	0	0.1	2.0	5.6	0.20	1.2	7.9	82	0	0		1			120	58
			No. of Samples	14	13	14	7	7	8	14	14	10	1	1	3	7		6		4	5	5
		4800'	Average	(Median) 2,400	16	6		0.12		8.3	0.87	3.6			0.6	1.7		2.1			160	71
			Maximum	> 2,400	18	8		0.15		8.8	1.8	5.6			1.3	3		5			170	82
			Minimum	1,700	13	4		0.1		7.6	0.2	2.4			0.2	1		1			140	64
			No. of Samples	3	3	4		3		3	3	3			3	3		3		3	3	3
		5000'	Average	(Median) 2,400	12	1	0.001	0.13	11.0	9.7	0.59	14	7.8	81		4		2.9			160	90
			Maximum	54,000	18	5	0.004	0.2	25.0	12.4	1.4	25	7.8	81		10		6.7			160	110
			Minimum	43	7.5	0	0	0.1	2.0	5.6	0.2	1.2	7.8	81		1		1			160	70
			No. of Samples	11	10	11	7	6	8	11	11	7	1	1		3		3		3	2	2
		5300'	Average	(Median) 6,200	13	6	0.08	0.17	11.0	9.4	0.73	10	7.8	82	0.4	1.6		1.1			160	98
			Maximum	>24,000	29	8	0.50	0.2	25.0	12.4	1.8	31	7.9	82	0.4	4		2			180	120
			Minimum	2,300	6.5	0	0	0.1	2.0	5.7	0.2	0.7	7.9	82	0.3	1		1			140	58
			No. of Samples	14	13	14	7	7	8	14	14	10	1	1	2	7		6		3	5	5
		5600'	Average	(Median) 8,600	22	2	0.003	0.16	11.5	9.3	0.77	12	8.0	82	0.5	8.8		7.1			160	100
			Maximum	>24,000	25	8	0.02	0.25	25.0	12.5	1.4	31	8.0	82	1.6	38.5		33.3			180	110
			Minimum	2,300	6.5	0	0	0.1	2.0	5.6	0.2	1.2	8.0	82	0	1		1			140	82
			No. of Samples	14	13	14	7	7	8	14	13	10	1	1	2	7		6		3	5	5

Table 21 - SUMMARY OF AVERAGE ANALYTICAL RESULTS - DETROIT RIVER (continued)

Sampling Point	Mileage Index No.	Distance from [illegible] Shore		Coliform [illegible] per [illegible]	Chlorides ppm	Phenols ppb	Ammonia as N ppm	[illegible] ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm	Turbidity ppm	pH	Alk. ppm	[illegible] ppm	Threshold Odor, Cold				Taste	Total Solids ppm	
																Raw No.	Raw Nature	Chlorinated No.	Chlorinated Nature		Total	Volatile
		[illegible]'	Average	(Median) 4,300	23	3	0.05	0.23	11.6	8.8	1.65	14	8.0	83	0.4	3.1		2.8			130	85
			Maximum	> 24,000	36	6	0.01	0.6	25.0	10.4	2.6	39	8.0	83	0.5	3		6.7			200	120
			Minimum	2,300	6.0	0	0	0.1	2.0	5.00	0.5	0.6	8.0	83	0.8	2		1			130	70
			No. of Samples	24	13	14	8	7	8	13	13	10	1	1	2	7		6		4	5	5
							[illegible]															
[illegible] Beach, Bay Point, (Near Mouth of Detroit River)	D- 3.0	[illegible]' & [illegible]'	Average	(Median) 5,400	31	11	0.20	0.35	[illegible] 10.0	9.3	3.23	22				5		2.5			220	130
			Maximum	9,300	60	30	0.38	0.35	20.5	12.9	6.0	26				6.7		4			300	180
			Minimum	430	18	0	0.004	0.35	0	7.0	0	1.1				3		1			140	70
			No. of Samples	9	9	9	7	2	6	9	9	7				2		2		2	2	2
		1000'	Average	(Median) 6,900	35	13	0.23	0.2	12.0	8.4	1.97	13				5.3		3.5			230	120
			Maximum	110,000	73	30	0.38	0.2	20.0	12.9	3.5	35				6.7		4			330	170
			Minimum	2,300	16	0	0.000	0.2	0	5.4	0.4	0.7				4		3			160	99
			No. of Samples	8	9	9	7	2	6	9	9	7				2		2		2	2	2
		2000'	Average	(Median) 24,000	31	9	0.08	0.23	12.0	9.4	2.1	13				4		2.5			230	90
			Maximum	> 240,000	77	20	0.48	0.25	20.0	13.0	3.4	23				4		4			290	180
			Minimum	4,000	15	0	0.10	0.2	0	5.2	1.2	1.5				4		1			160	64
			No. of Samples	8	9	9	7	2	6	9	9	7				2		2		2	2	2
		3000'	Average	(Median) 15,000	30	10	0.21	0.23	13.0	8.4	2.0	13				3		1			200	100
			Maximum	> 240,000	78	27	0.40	0.30	27.0	13.0	3.1	31				4		1			280	160
			Minimum	9,300	14	0	0	0.15	0	5.4	0.99	1.8				2		1			150	70
			No. of Samples	9	9	9	7	2	6	9	9	7				2		2		2	2	2
		4000'	Average	(Median) 43,000	40	8	28	0.2	11	8.7	2.3	11				9.3		1			220	100
			Maximum	110,000	67	15	0.30	0.2	26	13.0	3.6	31				13		1			280	140
			Minimum	15,000	14	0	0	0.2	0	5.4	1.1	1.0				6.7		1			130	60
			No. of Samples	9	9	9	7	2	6	9	9	7				2		2		2	2	2
		5000'	Average	(Median) 24,000	34	7	0.14	0.23	12	9.1	1.9	11				6		1			150	100
			Maximum	> 240,000	65	12	0.36	0.30	26	13.2	3.5	29				8		1			230	130
			Minimum	4,300	14	0	0	0.15	0	5.4	0.98	1.3				4		1			140	64
			No. of Samples	7	7	7	5	2	4	7	7	7				2		2		2	2	2
		6000'	Average	(Median) 43,000	36	6	0.15	0.23	11	8.7	2.3	13				5.4		1			200	110
			Maximum	> 240,000	68	15	0.36	0.30	26	13.2	3.6	26				6.7		1			210	120
			Minimum	7,500	19	0	0	0.15	0	5.1	1.1	1.8				4		1			180	96
			No. of Samples	9	9	9	7	2	6	9	9	7				2		2		2	2	2
		7000'	Average	(Median) 43,000	35	6	0.10	0.18	11	8.8	1.7	11				5.9		1.5			230	120
			Maximum	> 240,000	54	12	0.36	0.2	26.0	13.5	3.2	20				6.7		2			210	130
			Minimum	4,300	18	0	0	0.15	0	5.2	0.55	1.3				5		1			200	100
			No. of Samples	9	9	9	7	2	6	9	9	7				2		2		2	2	2
		8000'	Average	(Median) 22,000	30	4	0.07	0.18	11	9.1	1.7	11				4.5		1			190	120
			Maximum	46,000	53	12	0.30	0.20	26	13.3	2.4	20				5		1			200	120
			Minimum	4,300	17	0	0	0.15	0	5.4	0.86	1.2				4		1			170	120
			No. of Samples	9	9	9	7	2	6	9	9	7				2		2		2	2	2
		9000'	Average	(Median) 7,900	22	3	0.05	0.2	11	9.4	1.8	10				6		2.5			150	89
			Maximum	46,000	31	10	0.30	0.2	26	13.6	2.2	20				8		4			170	98
			Minimum	750	14	0	0	0.2	0	6.1	0.4	1.1				4		1			130	86
			No. of Samples	9	9	9	7	2	6	9	9	7				2		2		2	2	2
		10,000'	Average	(Median) 2,300	19	2	0.03	0.1	11	9.7	0.79	8				5		2			160	110
			Maximum	46,000	29	10	0.14	0.1	25.5	13.7	1.7	16				5		2			180	110
			Minimum	930	14	0	0	0.1	0	6.3	0.2	1.0				5		1			130	100
			No. of Samples	9	9	9	7	2	6	9	9	7				2		2		2	2	2

Table 21 —SUMMARY OF AVERAGE ANALYTICAL RESULTS— DETROIT RIVER (continued)

Sampling Point	Mileage Index No.	Distance from West Shore		Coliforms M.P.N. per 100 ml	Chlorides ppm	Phenols ppb	Ammonia as N ppm	Chlor. Dem. ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm	Turbidity ppm	pH	Alk. ppm	Oils ppm	Threshold Odor, Cold: Raw No.	Raw Nature	Chlorinated No.	Chlorinated Nature	Taste	Total Solids ppm: Total	Volatile
		11,000'	Average	(Median) 930	14	4	0	0.13	11	9.9	0.60	8				2.5		1			160	90
			Maximum	9,300	21	12	0	0.15	25.5	13.7	4.00	29				1		1			200	95
			Minimum	230	6	0	0	0.10	0	7.0	0.37	27				4		1			120	88
			No. of Samples	9	9	9	7	2	6	9	8	7				2		2		2	2	2
		12,000'	Average	(Median) 430	18	2	0	0.1	11	10.2	0.68	10				2.5		1			150	80
			Maximum	9,300	15	7	0	0.1	25.5	13.7	2.3	19				3		1			170	90
			Minimum	210	6.3	0	0	0.1	0	7.6	0.4	1.7				2		1			120	70
			No. of Samples	9	9	9	7	2	6	9	9	7				2		2		2	2	2
		13,000'	Average	(Median) 930	11	3	0	0.1	11	10.8	0.61	9				2.5		1			130	91
			Maximum	9,300	26	22	0	0.1	25.5	13.7	2.0	17				3		1			130	110
			Minimum	93	5.6	0	0	0.1	0	7.9	0.34	1.0				2		1			120	72
			No. of Samples	9	9	9	7	2	6	9	9	7				2		2		2	2	2
		14,000'	Average	(Median) 230	10	1	0	0.13	11	10.3	7.0	16				2		1			130	74
			Maximum	24,000	18	10	0	0.15	25.0	13.8	1.4	16				3		1			140	80
			Minimum	43	5.3	0	0	0.10	0	8.2	0.22	1.1				1		1			120	68
			No. of Samples	9	9	9	7	2	6	9	9	7				2		2		2	2	2
[illegible] (Cont'd.).	24- 3.9	15,000'	Average	(Median) 730	11	4	0	0.1	10.5	10.2	0.61	11				2.4		1			130	78
			Maximum	4,300	16	12	0	0.1	25.5	13.6	1.3	25				3		1			140	78
			Minimum	93	7.7	0	0	0.1	0	8.0	0.36	1				2		1			120	72
			No. of Samples	9	9	9	7	2	6	9	9	7				2		2		2	2	2
		16,000'	Average	(Median) 2,400	12	2	0	0.1	10.5	10.2	0.71	12			13.8	2.5		1			150	88
			Maximum	9,300	20	7	0	0.1	24.5	13.7	1.2	32			14.5	3		1			150	94
			Minimum	230	7.5	0	0	0.1	0	8.1	0.26	1.5			12	2		1			140	82
			No. of Samples	9	7	9	7	2	6	9	9	7			2	2		2		2	2	2
		16,500'	Average	(Median) 4,600	14	2	0	0.1	10.5	10.2	0.77	13				4		4			210	74
			Maximum	21,000	17	12	0	0.1	24.0	13.9	1.5	38				4		1			310	78
			Minimum	230	11	0	0	0.1	0	8.1	0	2.1				4		1			110	70
			No. of Samples	9	9	9	7	2	6	9	9	7				2		2		2	2	2
		17,500'	Average	(Median) 4,600	20	3	0.002	0.15	10.6	10.0	0.82	14				3.5		1			150	54
			Maximum	16,000	29	12	0.01	0.15	24.5	13.8	1.5	33				4		1			150	88
			Minimum	930	11	0	0	0.15	0	7.9	0.4	1.6				3		1			150	20
			No. of Samples	9	9	9	7	2	6	9	9	7				2		2		2	2	2
		18,500	Average	(Median) 4,600	21	4	0.003	0.13	10.5	10.1	0.96	29				3.5		1			150	72
			Maximum	12,000	32	16	0.02	0.15	25.5	14.0	1.5	62				5		1			150	72
			Minimum	730	11	0	0	0.10	0	7.8	0.6	1.6				2		1			150	72
			No. of Samples	9	9	9	9	2	6	9	9	7				2		2		2	1	1
		19,000'	Average	(Median) 7,500	24	3	0.002	0.15	11.0	10.0	0.89	16				3.5		1.5			160	83
			Maximum	> 24,000	38	8	0.01	0.15	25.5	14.0	1.4	36				5		2			160	92
			Minimum	2,100	12	0	0	0.15	0	7.6	0.2	1.3				2		1			160	74
			No. of Samples	9	9	9	7	2	6	9	9	7				2		2		2	2	2
		19,200'	Average	(Median) 4,300	25	5	0.002	0.15	11	10.0	0.83	20				4.9		1.5			220	160
			Maximum	11,000	34	25	0.01	0.10	25.5	13.5	1.7	33				6.7		2			260	130
			Minimum	2,300	12	0	0	0.00	0	7.4	0.2	1.7				3		1			170	78
			No. of Samples	6	9	9	9	2	6	9	9	7				2		2		2	2	2
		20,000'						CANADIAN SHORE														
			Average																			
			Maximum																			
			Minimum																			
			No. of Samples																			

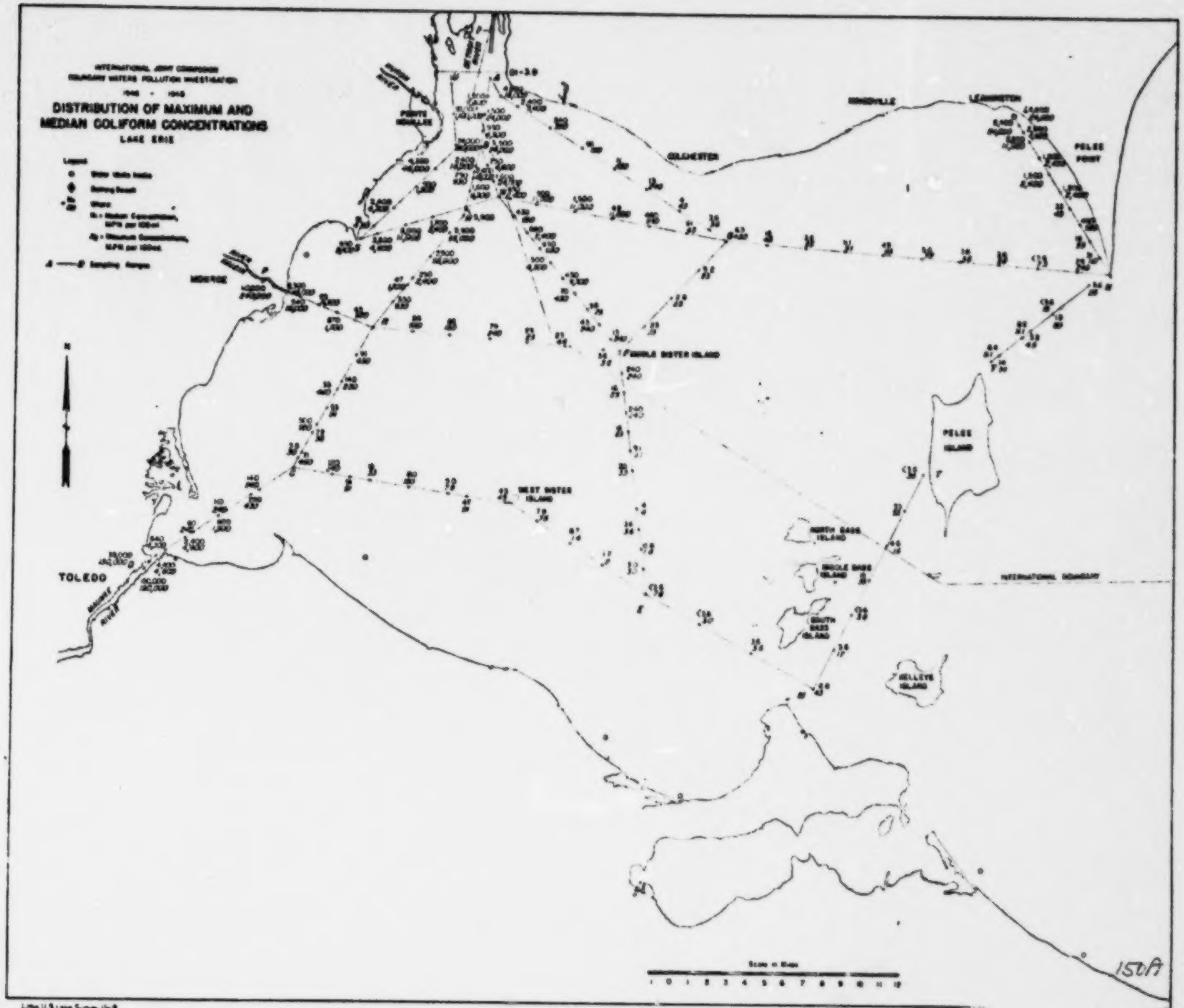
Lake Erie

The summary of average analytical results for samples taken in Lake Erie is presented in table 22. Samples were taken at the west end of the lake as far east as Pelee Island.

The distribution of maximum and median coliform concentrations is shown in figure 11. In United States waters the worst bacteriological conditions were found from the mouth of the Detroit River to the area lying below Pointe Mouillee. Median values here varied up to 93,000 per 100 ml., while maximum results rose to 1,100,000 per 100 ml. High concentrations were also found at the mouths of the Raisin and Maumee Rivers, but this pollution became well diluted within distances of 4 to 6 miles into the lake.

In Canadian waters high coliform concentrations were found at the mouth of the Detroit River and in the vicinity of Leamington. Median results were obtained as high as 4,600 for the former and 5,500 for the latter, with a maximum value of over 24,000 per 100 ml. for each place. There is no indication that the results at Leamington are due to the Detroit River discharges. Pollution from the Detroit River is diffused in a fan-like pattern and is generally dissipated in a distance of 12 miles from the mouth. Waters in the central portion of the area sampled were generally of good bacterial quality.

Other analytical results indicated the same conditions as those shown by the bacteriological analyses.

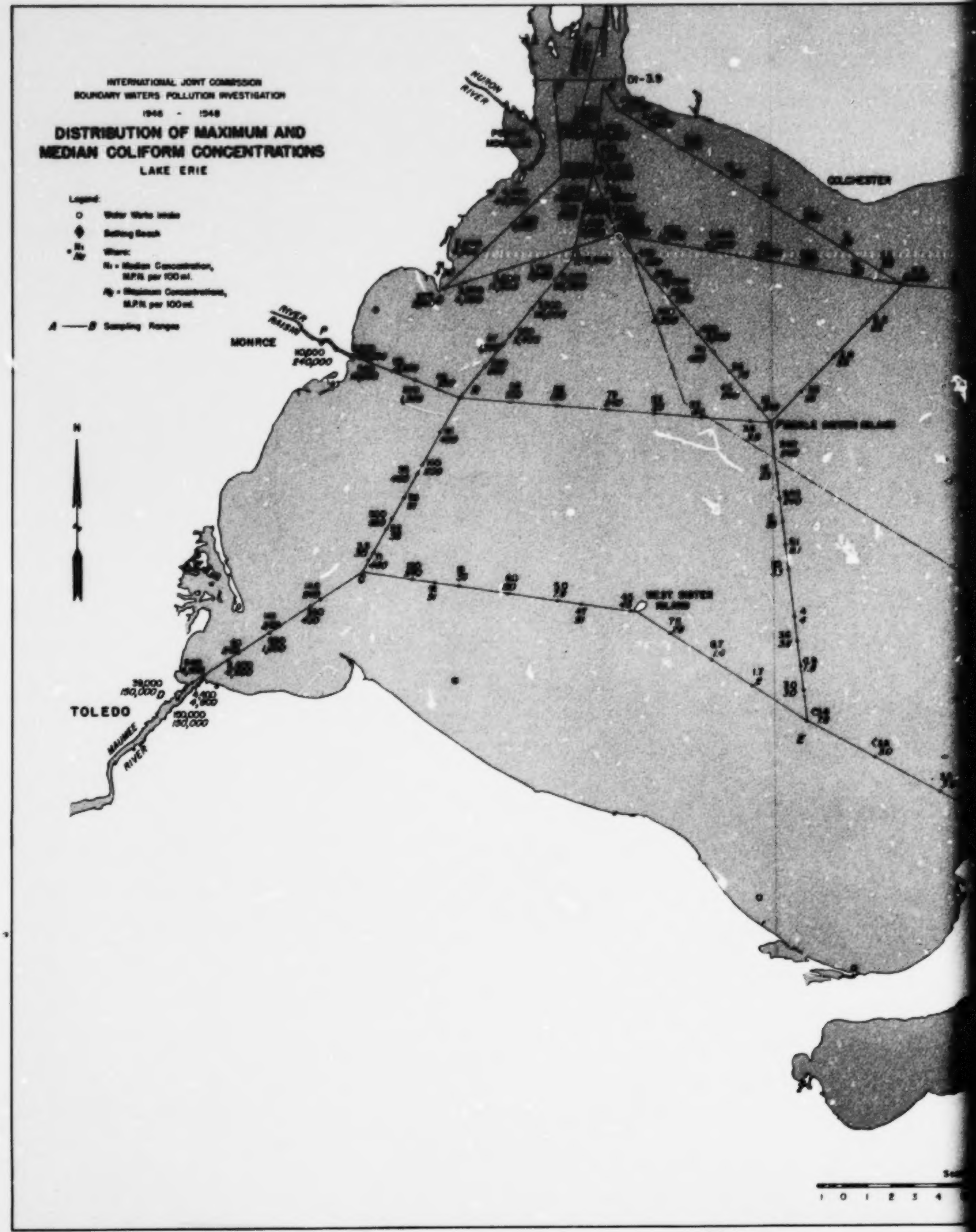

INTERNATIONAL JOINT COMMISSION
BOUNDARY WATERS POLLUTION INVESTIGATION
1946 - 1948
DISTRIBUTION OF MAXIMUM AND MEDIAN COLIFORM CONCENTRATIONS
LAKE ERIE
Legend
Water Works Intake
Bathing Beach
Where:
Xn = Median Concentration, MPN per 100ml
Xy = Maximum Concentration, MPN per 100ml
A —— B Sampling Ranges
N
MONROE
TOLEDO
MAUMEE RIVER
POINTE MOUILLEE
COLCHESTER
KINGSVILLE
LEAMINGTON
PELEE POINT
MIDDLE SISTER ISLAND
WEST SISTER ISLAND
PELEE ISLAND
NORTH BASS ISLAND
MIDDLE BASS ISLAND
SOUTH BASS ISLAND
KELLEYS ISLAND
INTERNATIONAL BOUNDARY
Scale in Miles
1 0 1 2 3 4 5 6 7 8 9 10 11 12

150A

Litho U S Lake Survey 1949

Figure 11

A


INTERNATIONAL JOINT COMMISSION
BOUNDARY WATERS POLLUTION INVESTIGATION
1946 - 1948
DISTRIBUTION OF MAXIMUM AND MEDIAN COLIFORM CONCENTRATIONS
LAKE ERIE
Legend:
Water Works Intake
Bathing Beach
Where:
N₁ = Median Concentration, M.P.N. per 100 ml.
N₂ = Maximum Concentrations, M.P.N. per 100 ml.
A —— B Sampling Ranges
HURON RIVER
DI-3.9
COLCHESTER
RIVER RAISIN
MONROE
10,000
240,000
MIDDLE SISTER ISLAND
WEST SISTER ISLAND
TOLEDO
39,000
150,000
4,400
4,900
150,000
150,000
MAUMEE RIVER
N
1 0 1 2 3 4

Litho U S Lake Survey 1949

Figure 11

B

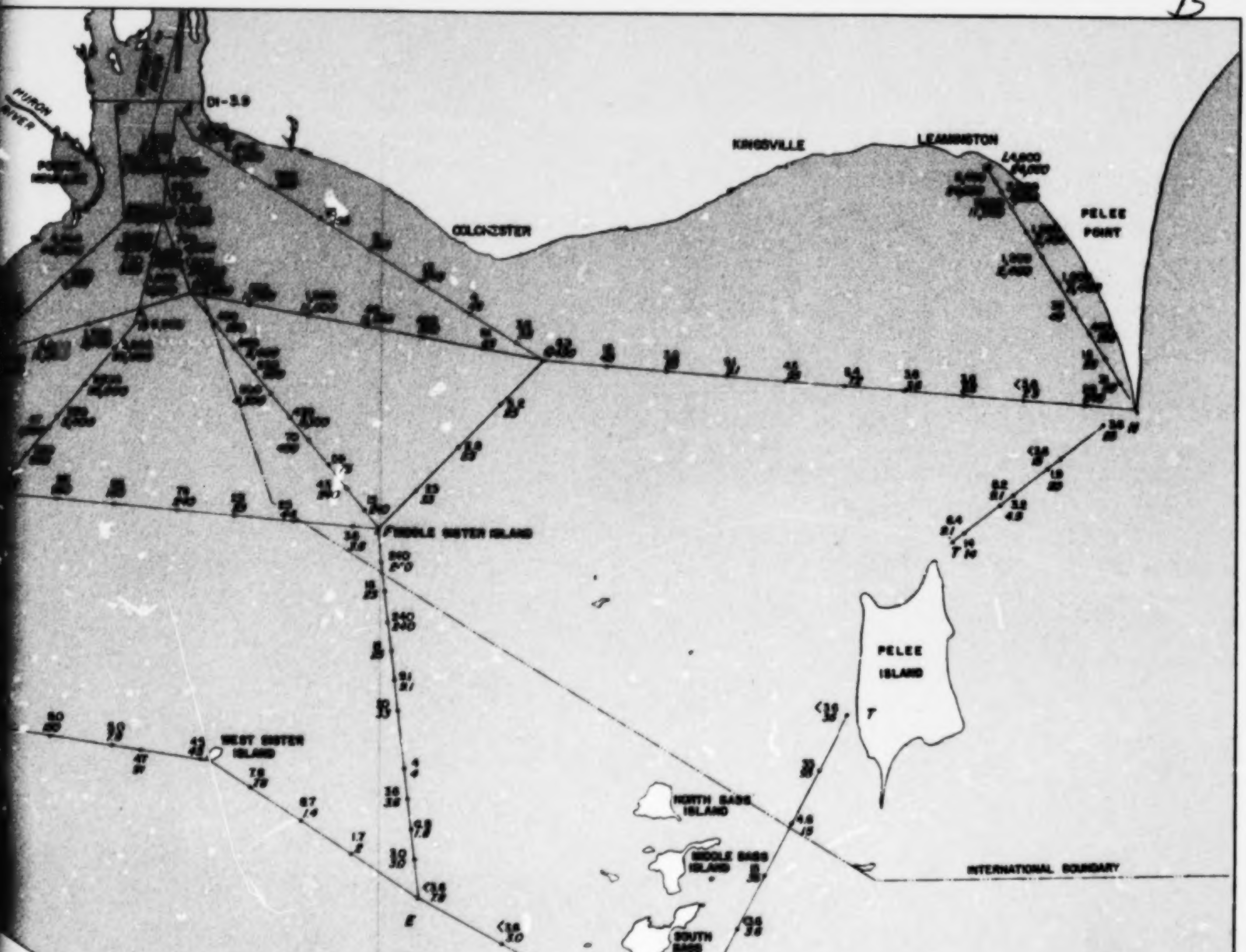

HURON RIVER
DI-3.9
KINGSVILLE
LEAMINGTON
COLCHESTER
PELEE POINT
MIDDLE SISTER ISLAND
PELEE ISLAND
WEST SISTER ISLAND
NORTH BASS ISLAND
MIDDLE BASS ISLAND
SOUTH BASS ISLAND
KELLEYS ISLAND
INTERNATIONAL BOUNDARY
Scale in Miles
1 0 1 2 3 4 5 6 7 8 9 10 11 12

Figure 11

Table 22 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – LAKE ERIE

[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	Average	(Median) [illegible]	[illegible]	6	[illegible]	[illegible]	[illegible]	9.7	[illegible]	7	[illegible]	[illegible]		1			[illegible]	
Right to Bar Point.		Maximum	[illegible]	13	[illegible]	[illegible]	[illegible]	[illegible]	11.0	[illegible]	16	[illegible]	3		1			[illegible]	[illegible]
		Minimum	420	[illegible]	0	0	0.1	[illegible]	[illegible]	[illegible]	1.6	[illegible]	1		1			[illegible]	[illegible]
		No. of Samples	[illegible]	13	13	10	2	[illegible]	[illegible]	13	7	1	[illegible]		0		0	2	2
[illegible]	[illegible]	Average	(Median) [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		1			[illegible]	[illegible]
Right to Bar Point.		Maximum	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		1			[illegible]	[illegible]
		Minimum	[illegible]	[illegible]	0	0	0	[illegible]	7.0	[illegible]	[illegible]		1		1			[illegible]	[illegible]/
		No. of Samples	11	11	11	[illegible]	[illegible]	[illegible]	[illegible]	11	3		[illegible]		[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	Average	(Median) [illegible]	11	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		1			[illegible]	[illegible]
Right to Bar Point.		Maximum	4,[illegible]	[illegible]	7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		1			[illegible]	[illegible]
		Minimum	[illegible]	[illegible]	0	0	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	1		1			[illegible]	[illegible]
		No. of Samples	[illegible]	11	11	[illegible]	[illegible]	[illegible]	[illegible]	11	3	1	[illegible]		[illegible]		[illegible]	3	3
[illegible]	[illegible]	Average	(Median) [illegible]	[illegible]	3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9	[illegible]	1		1			[illegible]	[illegible]
Right to Bar Point.		Maximum	>[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11.7	[illegible]	[illegible]	[illegible]	1		1			[illegible]	[illegible]
		Minimum	420	4.4	0	0	0.1	9.5	7.3	[illegible]	1.7	[illegible]	1		1			[illegible]	[illegible]
		No. of Samples	[illegible]	[illegible]	[illegible]	9	[illegible]	0	[illegible]	[illegible]	6	1	[illegible]		0			3	3
[illegible] opposite Bar	[illegible]	Average	(Median) [illegible]	[illegible]	0	0		[illegible]	[illegible]										
Point to Stony Point.		Maximum	[illegible]	[illegible]	0	0		[illegible]	[illegible]										
		Minimum	[illegible]	[illegible]	0	0		[illegible]	[illegible]										
		No. of Samples	1	1	1	1		1	1										
	1.5	Average	(Median) [illegible]	27	6	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]								
		Maximum	1,300,000	[illegible]	15	[illegible]		[illegible]	13.3	2.7	[illegible]								
		Minimum	9,300	[illegible]	0	0		0	7.5	[illegible]	16								
		No. of Samples	3	3	3	3		[illegible]	3	3	3								
	[illegible]	Average	(Median) [illegible]	[illegible]	[illegible]	[illegible]		[illegible]	9.9	1.7	[illegible]								
		Maximum	120,000	[illegible]	[illegible]	[illegible]		[illegible]	13.4	2.7	[illegible]								
		Minimum	[illegible]	[illegible]	0	[illegible]		[illegible]	7.0	1.1	16								
		No. of Samples	3	3	3	3		1	3	3	3								
	[illegible]	Average	(Median) [illegible]	[illegible]	7	[illegible]		[illegible]	10.7	[illegible]	[illegible]								
		Maximum	[illegible]	44	[illegible]	[illegible]		16.5	13.8	3.1	[illegible]								
		Minimum	430	[illegible]	0	0		0	[illegible]	1.6	16								
		No. of Samples	3	3	3	3		[illegible]	3	3	3								
	[illegible]	Average	(Median) [illegible]	[illegible]	4	[illegible]		[illegible]	11.0	[illegible]	[illegible]								
		Maximum	1,300	[illegible]	7	[illegible]		16.0	13.3	2.7	[illegible]								
		Minimum	[illegible]	[illegible]	0	0		0	9.3	1.7	16								
		No. of Samples	3	3	3	3		[illegible]	3	3	3								
	[illegible]	Average	(Median) [illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]								
		Maximum	4,300	[illegible]	[illegible]	[illegible]		16.0	[illegible]	1.6	[illegible]								
		Minimum	[illegible]	[illegible]	0	0		[illegible]	[illegible]	1.1	[illegible]								
		No. of Samples	3	3	3	3		[illegible]	3	3	3								

Table 22 —SUMMARY OF AVERAGE ANALYTICAL RESULTS— LAKE ERIE (continued)

[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]				[illegible]	[illegible]	
													[illegible]		[illegible]			[illegible]	[illegible]
													[illegible]	[illegible]	[illegible]	[illegible]			
	[illegible]	Average	(Median) [illegible]	26	3	0.03		9.0	10.7	1.4	18								
		Maximum	420	30	5	0.05		16.0	12.0	2.0	20								
		Minimum	39	22	0	0		0	8.7	1.0	16								
		No. of Samples	3	3	3	3		2	3	3	3								
	20.0 (D)	Average	(Median) [illegible]	26	4	0.032		9.0	10.5	1.6	27								
		Maximum	2,400	36	7	0.05		16.0	12.7	2.0	30								
		Minimum	[illegible]	20	0	0		0	8.6	1.0	22								
		No. of Samples	4	4	4	4		2	4	4	4								
[illegible]	1.0	Average	(Median) 2,400	30	3		0.2		8.1	2.3	1.0	88	2		1			180	61
[illegible]		Maximum	24,000	35	6		0.5		8.8	2.0	3.3	88	3		1			200	70
[illegible]		Minimum	2,400	26	0		0.1		6.0	0.8	0.7	87	1		1			160	53
Light.		No. of Samples	[illegible]	4	4		2		3	4	4	2	2		2		2	4	4
	1.5	Average	(Median) 2,400	27	3	0.05		14.6	10.0	1.6	20								
		Maximum	9,100	37	10	0.26		20.0	11.7	1.8	28								
		Minimum	30	24	0	0		9.0	7.0	0.67	0								
		No. of Samples	5	5	5	5		5	6	6	2								
	3.0	Average	(Median) 230	32	3		0.05		8.9	0.6	0.8		2		1			160	66
		Maximum	750	36	6		0.20		8.4	0.8	1.1		3		1			180	70
		Minimum	230	26	0		0.20		8.0	0.4	0.7		2		1			140	58
		No. of Samples	2	2	2		2		2	2	2		2		2			2	2
	3.0	Average	(Median) 1,500	28	1	0.05	0.12	14.0	9.3	0.97	3.6	85	2		1			160	56
		Maximum	9,100	30	6	0.14	0.09	20.0	11.4	1.6	9	88	2		1			180	70
		Minimum	90	9	0	0	0.20	10.0	7.5	0.0	0.7	81	1		1			130	48
		No. of Samples	9	9	9	5	3	6	7	9	6	2	2		2		2	6	6
	4.5	Average	(Median) 1,500	28	0	0.05		14.0	9.7	1.2	6								
		Maximum	11,000	37	0	0.16		23.0	10.6	1.6	8								
		Minimum	230	12	0	0		10.5	8.1	0.5	8								
		No. of Samples	4	4	4	4		4	4	4	2								
	5.0	Average	(Median) 2,100	27	0	0.05	0.15	14.5	9.2	0.8	2.3	85	3		1			160	52
		Maximum	15,000	51	0	0.14	0.15	23.0	10.9	1.8	3.8	88	3		1			180	60
		Minimum	70	7.3	0	0	0.15	11.0	6.8	0.2	0.7	88	3		1			90	30
		No. of Samples	6	6	6	3	1	4	5	7	3	2	1		1		1	3	3
	7.5	Average	(Median) 730	28	10	0.03		13.0	10.0	0.25	8								
		Maximum	2,400	35	35	0.05		20.5	11.1	1.8	8								
		Minimum	91	10	0	0.0		10.0	7.6	0.32	8								
		No. of Samples	3	4	4	4		4	4	4	1								
	[illegible]	Average	(Median) 27	29	1		0.1		8.3	0.05	2.4	88	2		1			180	52
		Maximum	1,500	41	2		0.2		7.4	1.40	4.1	90	2		1			200	60
		Minimum	0	15	0		0.1		9.0	0.20	1.0	88	1		1			120	38
		No. of Samples	4	4	4		2		2	4	4	2	2		2		1	4	4

Table 22 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – LAKE ERIE (continued)

Sampling Range & Location	Station (miles)		Coliforms MPN per 100 ml	Chlorides ppm	Phenols ppb	Amm. as N ppm	[illegible] ppm	Temp. °C	D.O. ppm	B.O.D. 5-day ppm	Turbidity ppm	Alk. ppm	Threshold Odor Cold				Taste	Total Solids ppm	
													Raw		Chlorinated				
													No.	Nature	No.	Nature		Total	Volatile
[illegible] Detroit River Light	[illegible]	Average	(Median) 330	22	2	0.14		15.0	9.9	0.71	6								
to East Channel Outer Bay		Maximum	930	46	7	0.30		24.0	11.8	1.8	6								
to [illegible] Light to Toledo		Minimum	230	11	0	0.05		10.5	7.2	0.2	6								
Harbor. (Cont'd)		No. of Samples	4	4	4	4		4	4	4	1								
	10.0(C)	Average	(Median) 170	26	0	0.10	0.10	17.0	9.7	1.33	6	89	2		1			160	60
		Maximum	1,000	30	0	0.21	0.10	24.5	11.3	1.60	8	90	2		1			280	72
		Minimum	11	18	0	0	0.10	10.0	7.9	0.66	2	87	2		1			120	50
		No. of Samples	8	6	8	5	1	5	6	8	5	3	1		1			3	3
	10.0	Average	(Median) 91	24	0	0.05		13.0	10.5	1.20	6								
		Maximum	430	29	0	0.16		21.0	11.4	1.40	8								
		Minimum	43	19	0	0		10.0	8.8	0.85	8								
		No. of Samples	3	3	3	3		3	3	3	1								
	12.5	Average	(Median) 140	26	0	0.08		17.0	9.8	1.2	10								
		Maximum	230	30	0	0.16		24.0	11.8	1.3	10								
		Minimum	43	23	0	0		10.5	8.3	1.1	10								
		No. of Samples	2	2	2	2		2	2	2	1								
	14.0	Average	(Median) 37	21	0		0.1		9.0	1.1	4.3	86			1			160	60
		Maximum	460	26	0		0.1		9.0	1.6	7.5	89			1			180	75
		Minimum	2	13	0		0.1		9.0	0.6	1.0	78			1			140	58
		No. of Samples	3	3	3		1		1	3	3	1			1			1	1
	15.0	Average	(Median) 53	21	0	0		17.5	10.8	2.2	11								
		Maximum	91	26	0	0		24.5	11.4	3.3	11								
		Minimum	15	16	0	0		11.0	10.3	1.1	11								
		No. of Samples	2	2	2	2		2	4	2	1								
	16.0	Average	(Median) 500	20	3		0.1		8.8	1.5	11	87	3		1			210	84
		Maximum	900	31	6		0.1		8.8	1.6	20	96	3		1			232	92
		Minimum	79	25	0		0.1		8.8	1.4	1.4	80	3		1			190	76
		No. of Samples	2	2	2		1		1	2	2	2	1		1			2	2
	16.5	Average	(Median) 22	16	4	0		18.0	10.2	1.6	10								
		Maximum	36	24	8	0		24.5	11.5	1.7	10								
		Minimum	7.2	11	0	0		10.5	8.9	1.1	10								
		No. of Samples	2	2	2	2		2	2	2	1								
	18.0	Average	(Median) 3.6	17	0	0		10.6	10.1	1.19	14								
		Maximum	< 30	20	0	0		24.5	11.3	1.90	14								
		Minimum	3.6	11	0	0		10.5	8.9	0.88	14								
		No. of Samples	2	2	2	2		2	2	2	1								
	18.5(C)	Average	(Median) 72	23	4	0	0.15	24.5	9.3	1.6	19	92	1		1			220	74
		Maximum	460	25	20	0	0.15	24.5	10.0	2.5	39	100	1		1			260	80
		Minimum	< 3.6	21	0	0	0.15	24.0	9.0	0.8	17	82	1		1			200	70
		No. of Samples	5	5	5	2	1	2	3	5	5	2	1		1			3	3

Table 22 —SUMMARY OF AVERAGE ANALYTICAL RESULTS—LAKE ERIE (continued)

Sampling Range & Location	Station (miles)		Coliforms M.P.N. per 100 ml	Chlorides ppm	Phenols ppb	Amm. as N ppm	Chlor. Dem. ppm	Temp. °C	D.O. ppm	B.O.D. 5-day ppm	Turbidity ppm	Alk. ppm	Threshold Odor Cold: Raw No.	Raw Kind	Chlorinated No.	Chlorinated Kind	Taste	Total Solids ppm: Total	Volatile
[illegible]	20.5	Average	(Median) 240	19	3	0		24.0	10.1	2.4	29								
[illegible]		Maximum	240	20	5	0		24.5	10.8	2.7	31								
		Minimum	43	18	0	0		23.5	9.5	2.1	27								
		No. of Samples	2	2	2	2		2	2	2	2								
	21.0	Average	(Median) 280	13	0	0.05		11.5	11.1	0.75									
		Maximum	430	13	0	0.06		11.5	11.1	0.77									
		Minimum	[illegible]	13	0	0.03		11.0	11.0	0.72									
		No. of Samples	2	2	2	2		2	2	2									
	22.5	Average	(Median) 110	21	6	0	0.3	24.0	10.0	2.7	22.0	96	3		1			210	66
		Maximum	240	23	24	0	0.3	24.0	10.7	5.1	37	99	3		1			230	86
		Minimum	37	19	0	0	0.3	23.5	8.6	0.4	1.4	93	3		1			190	50
		No. of Samples	4	4	4	2	1	2	3	4	4	2	1		1		1	2	2
	23.0	Average	(Median) 800	11	0	0.16		13.0	10.4	0.76									
		Maximum	1,900	12	0	0.22		13.0	10.5	0.82									
		Minimum	91	9	0	0.10		13.0	10.2	0.70									
		No. of Samples	2	2	2	2		2	2	2									
	24.5	Average	(Median) 60	21	3	0	0.3	23.5	10.9	3.5	29	100							
		Maximum	240	23	10	0	0.3	23.5	13.4	5.8	33	100	2		1			230	42
		Minimum	21	19	0	0	0.3	23.5	8.5	0.6	3	100	2		1			200	30
		No. of Samples	4	4	4	2	1	2	3	4	4	2	1		1			2	2
	25.0	Average	(Median) 2,100	8.1	3	0.29		14.0	9.5	1.04									
		Maximum	4,600	8.2	5	0.40		14.0	9.9	1.20									
		Minimum	230	8.0	0	0.17		13.5	9.0	0.87									
		No. of Samples	2	2	2	2		2	2	2									
	26.5	Average	(Median) 540	20	0	0.47	0.55	25.0	8.4	3.5	26	110	4		2			270	47
		Maximum	4,300	22	0	0.80	0.55	25.5	12.8	6.2	45	110	4		2			280	70
		Minimum	540	19	0	0.14	0.55	24.5	3.7	1.4	3	100	4		2			250	24
		No. of Samples	4	4	4	2	1	2	3	4	4	2	1		1		1	2	2
	27.0	Average	(Median) 4,450	7.2	4	0.24		14.0	9.3	1.3									
		Maximum	4,600	7.3	7	0.30		14.0	9.4	1.3									
		Minimum	4,300	7.0	0	0.17		13.5	9.1	1.3									
		No. of Samples	2	2	2	2		2	2	2									
	27.5	Average	(Median) 39,000	22	10	0.85	0.40	25.5	3.2	2.0	19	115	4		1			270	110
		Maximum	150,000	28	40	0.90	0.40	26.0	4.7	3.40	32	120	4		1			280	130
		Minimum	1,600	18	0	0.80	0.40	25.0	1.8	0.58	2	110	4		1			260	88
		No. of Samples	4	4	4	2	1	2	3	4	4	2	1		1		1	2	2
	29.0(D)	Average	(Median) 150,000	14	0	0.44	0.40	15.5	6.0	2.7	2.1	130	4		1			320	90
		Maximum	150,000	26	0	0.50	0.40	15.5	7.4	2.8	2.1	130	4		1			320	90
		Minimum	5,400	7.8	0	0.38	0.40	15.0	4.0	2.5	2.1	130	4		1			320	90
		No. of Samples	3	3	3	2	1	2	3	3	1	1	1		1		1	1	1

Table 22 — SUMMARY OF AVERAGE ANALYTICAL RESULTS — LAKE ERIE (continued)

Sampling Range & Location	Station (miles)		Coliform M.P.N. per 100 ml.	Chloride ppm	Phenols ppb	Amm. as N ppm	Chlor. Dem. ppm	Temp. °C	D.O. ppm	B.O.D. 5-day ppm	Turbidity ppm	Alk. ppm	Threshold Odor Unit				Taste	Total Solids ppm	
													Raw		Chlorinated				
													No.	Nature	No.	Nature		Total	Volatile
	1.0	Average	(Median) 4,600	31	3	0.057	0.10	22	8.8	0.78	5.2	84	1		1			150	130
		Maximum	16,000	45	8	0.21	0.10	24.0	10.5	1.20	10	84	1		1			230	150
		Minimum	930	13	0	0	0.10	14.0	7.8	0.36	1.1	84	1		1			150	64
		No. of Samples	5	5	5	3	1	3	3	4	4	1	1		1		1	[illegible]	[illegible]
A-G, Detroit River East Channel and Bay to Colchester Reef Light	2.0	Average	(Median) 2,400	27	2	0.080	0.15	21.0	8.7	0.63	6	86	3		1			200	140
		Maximum	5,400	60	8	0.21	0.15	24.5	10.5	1.40	10	86	3		1			254	160
		Minimum	240	11	0	0	0.15	14.0	7.8	0.27	2	86	3		1			146	50
		No. of Samples	5	5	5	3	1	3	4	5	4	1	1		1		1	2	2
	4.0	Average	(Median) 240	25	3	0.14	0.10	21.0	8.9	0.98	4.4	86	4		1			180	110
		Maximum	350	60	8	0.14	0.10	25.0	10.7	2.00	9	86	4		1			200	160
		Minimum	93	7.5	0	0	0.10	14.0	7.2	0.40	0.7	86	4		1			140	50
		No. of Samples	5	5	5	3	1	3	4	5	4	1	1		1		1	2	2
	6.0	Average	(Median) 93	21	1	0.05	0.15	20.5	9.0	1.05	4	85	5		4			170	90
		Maximum	150	51	6	0.14	0.15	24.5	10.6	2.60	8	85	5		4			200	130
		Minimum	48	6.1	0	0	0.15	13.0	7.6	0.54	1	85	5		4			130	48
		No. of Samples	5	5	5	3	1	3	4	5	4	1	1		1		1	2	2
	8.0	Average	(Median) 11	20	5	0.31	0.10	21.0	9.1	0.66	4	85	1		1			150	80
		Maximum	430	39	17	0.92	0.10	25.0	10.5	1.20	8	85	1		1			198	106
		Minimum	3.6	13	0	0	0.10	13.0	7.6	0.30	1	85	1		1			130	50
		No. of Samples	4	5	5	3	1	3	4	5	4	1	1		1		1	2	2
	10.0	Average	(Median) 13	19	6	0	0.10	20.5	9.2	0.99	4	87	1		1			140	74
		Maximum	240	32	25	0	0.10	25.0	10.4	2.20	7	87	1		1			140	100
		Minimum	< 3.6	13	0	0	0.10	12.0	7.6	0.48	1	87	1		1			130	48
		No. of Samples	5	5	5	3	1	3	4	5	4	1	1		1		1	2	2
	12.0	Average	(Median) 4.0	19	3	0.02	0.15	20.5	8.8	0.94	4	85	1		1			130	68
		Maximum	43	27	7	0.06	0.15	25.0	10.1	1.50	8	85	1		1			130	98
		Minimum	2	14	0	0	0.15	12.0	7.2	0.30	1	85	1		1			120	38
		No. of Samples	5	5	5	3	1	3	4	5	4	1	1		1		1	2	2
	14.0	Average	(Median) 3.6	16	2	0		21.0	9.8										
		Maximum	3.6	16	12	0		25.0	10.1	1.10	7								
		Minimum	3.0	16	0	0		12.0	9.2	0.60	6								
		No. of Samples	3	3	3	2		3	3	3	2								
	15.0(a)	Average	(Median) 6.3	17	3	0	0.15	22.5	9.4	1.20	5.8	87	1		1			120	87
		Maximum	430	24	16	0	0.15	25.0	10.5	1.80	15	87	4		1			140	130
		Minimum	0	15	0	0	0.15	15.0	8.0	0.56	1.7	87	1		1			90	90
		No. of Samples	8	8	7	4	2	4	7	8	7	1	2		2		8	3	3
G-H, Colchester Reef to Pelee Point Life Saving Station.	17.0	Average	(Median) 16	15	0	0		25.0	9.4	1.14	9								
		Maximum	43	16	0	0		25.5	9.7	1.80	17								
		Minimum	3.6	14	0	0		24.5	8.8	0.58	4.8								
		No. of Samples	4	4	4	4		3	4	4	4								

Table 22 —SUMMARY OF AVERAGE ANALYTICAL RESULTS— LAKE ERIE (continued)

Sampling Range & Location	Station (miles)		Coliforms M.P.N. per 100 ml.	Chlorides ppm	Phenols ppb	Amm. as N ppm	Other Org. ppm	Temp. °C	D.O. ppm	B.O.D. 5-day ppm	Turbidity ppm	Alk. ppm	Threshold Odor (cold) Raw No.	Raw Nature	Chlorinated No.	Chlorinated Nature	Taste	Total Solids ppm Total	Volatile
	19.0	Average	(Median) 3.6	16	0	0		25.0	9.4	1.15	9								
		Maximum	23	16	0	0		25.0	9.7	2.1	16								
		Minimum	<3.6	15	0	0		24.5	8.7	0.66	5								
		No. of Samples	4	4	4	4		3	4	4	4								
	21.0	Average	(Median) 9.1	15	0	0		25.0	9.5	0.85	10								
		Maximum	9.1	16	0	0		25.0	9.8	1.30	21								
		Minimum	<3.6	14	0	0		24.5	8.9	0.64	6								
		No. of Samples	4	4	4	4		3	4	3	4								
U-E, Colchester Reef Light to Pelee Point Life Saving Station. (Cont'd)	23.0	Average	(Median) 43	16	0	0		25.0	9.4	0.72	10								
		Maximum	93	16	0	0		25.0	9.7	1.20	20								
		Minimum	<3.6	15	0	0		24.5	8.8	0.60	6								
		No. of Samples	4	4	4	4		3	4	4	4								
	25.0	Average	(Median) 5.4	16	0	0		25.0	9.2	0.84	11								
		Maximum	7.2	18	0	0		25.5	9.3	1.0	26								
		Minimum	<3.6	15	0	0		25.0	9.0	0.58	5								
		No. of Samples	4	4	4	4		3	4	4	4								
	27.0	Average	(Median) 3.6	27	1	0		25.0	9.1	0.99	10								
		Maximum	3.6	29	4	0		25.5	9.2	1.2	18								
		Minimum	<3.6	18	0	0		25.0	9.0	0.76	5								
		No. of Samples	4	4	4	4		3	4	4	4								
	29.0	Average	(Median) <3.6	16	1	0		25.0	9.2	0.80	9								
		Maximum	<3.6	18	4	0		25.5	9.4	1.1	16								
		Minimum	<3.6	14	0	0		24.5	8.9	0.52	5								
		No. of Samples	4	4	4	4		3	4	4	4								
	31.0	Average	(Median) 3.6	17	0	0.002		25.0	8.9	0.74	8								
		Maximum	7.3	20		0.006		25.5	9.3	0.96	14								
		Minimum	<3.6	15	0	0		24.5	8.5	0.58	3								
		No. of Samples	4	4	4	4		3	4	4	4								
	33.0	Average	(Median) 29	17	3	0		25.0	8.8	0.72	7								
		Maximum	240	18	10	0		25.5	9.7	0.98	10								
		Minimum	3.6	16	0	0		24.5	8.1	0.40	4								
		No. of Samples	4	4	4	4		3	4	4	4								
D-W. Detroit Light to East Channel and Buoy	1.0	Average	(Median) 730	18	3	0.01	0.15	13.0	10.0	0.74	7.6	68	4		4			200	76
		Maximum	4,600	23	7	0.05	0.15	13.0	10.7	1.40	27	68	4		4			310	78
		Minimum	240	6	0	0	0.15	12.5	8.0	0.34	2.6	68	4		4			130	71
		No. of Samples	7	6	6	4	1	3	6	7	3	1	1		1		1	2	2
	2.0	Average	(Median) 1,0[illegible]	11	2	0.02	0.1	13.0	9.9	1.10	7	68	4		1			130	90
		Maximum	24,000	20	6	0.06	0.1	13.0	10.0	3.0	18	68	4		1			150	100
		Minimum	93	5	0	0	0.1	12.5	7.8	0.68	1.6	68	4		1			100	64
		No. of Samples	7	7	7	5	1	3	6	7	4	1	1		1		1	2	2

Table 22 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – LAKE ERIE (continued)

Sampling Range & Location	Station (miles)		Coliforms M.P.N. per 100 ml	Chlorides ppm	Phenols ppb	Amm. as N ppm	[illegible] ppm	Temp. °C	D.O. ppm	B.O.D. 5-day ppm	Turbidity ppm	Alk. ppm	Threshold Odor Cold				Taste	Total Solids ppm	
													Raw		Chlorinated				
													No.	Descr.	No.	Descr.		Total	Volatile
U-S, Detroit River Light to	3.0(?)	Average	(Median) 930	12	1	0.02	0.3	13.5	9.9	0.9	6	88	6.7		1			130	72
East Channel and Buoy (Cont'd)		Maximum	2,400	23	4	0.07	0.3	14.0	10.8	1.0	12	88	6.7		1			140	96
		Minimum	150	6	0	0	0.3	12.5	8.0	0.40	1.2	88	6.7		1			120	60
		No. of Samples	7	7	7	5	1	3	6	7	4	1	1		1		1	2	2
U-S, Detroit River East	5.0	Average	(Median) 350	7	1	0.06	0.1	14.5	9.9	0.79	8		1		1			150	140
Channel Outer Buoy to		Maximum	11,000	23	2.0	0.12	0.2	15.0	10.6	1.20	14		1		1			150	140
Colchester Reef Light		Minimum	49	5	0	0	0	14.0	9.4	0.46	1.4		1		1			150	140
		No. of Samples	4	4	3	3	2	3	4	4	2		1		1		1	1	1
	7.0	Average	(Median) 1,500	20	2	0.09	0.15	14.5	9.5	1.25	7		4		1			150	130
		Maximum	11,000	30	5	0.18	0.15	15.0	10.0	2.2	18		4		1			150	130
		Minimum	79	17	0	0	0.15	14.0	9.0	0.25	1.3		4		1			150	130
		No. of Samples	4	4	3	3	1	2	4	4	2		1		1		1	1	1
	9.0	Average	(Median) 84	22	4	0.05	0.2	14.0	9.6	0.79	6		2		1			130	130
		Maximum	>11,000	30	18	0.14	0.2	15.5	10.4	1.0	11		2		1			130	130
		Minimum	36	16	0	0	0.1	13.0	9.0	0.08	1.2		2		1			130	130
		No. of Samples	4	4	3	3	1	2	4	4	2		1		1		1	1	1
	11.0	Average	(Median) 480	18	3	0.02	0.1	14.5	9.9	0.61	7		2		1			150	120
		Maximum	930	25	10	0.06	0.1	15.0	10.4	1.2	13		2		1			150	120
		Minimum	<23	14	0	0	0.1	14.0	9.0	0.2	1.1		2		1			150	120
		No. of Samples	4	4	3	3	1	2	4	4	2		1		1		1	1	1
	13.0	Average	(Median) 9.1	16	6	0	0.15	14.5	10.1	1.18	7		1		1			110	110
		Maximum	43	17	13	0	0.15	15.0	10.5	2.0	11		1		1			110	110
		Minimum	3.6	14	0	0	0.15	13.5	9.4	0.08	1.8		1		1			110	110
		No. of Samples	4	4	3	3	1	2	4	4	2		1		1		1	1	1
U-F, Detroit River East	[illegible]	Average	(Median) 430	8.0	5.7	0		13.8	10.6	0.62	11								
Channel Outer Buoy to Middle		Maximum	930	10	15	0		13.5	11.0	0.64	11								
Sister Isl.		Minimum	91	6.9	0	0		13.0	10.2	0.60	11								
		No. of Samples	3	3	3	3		2	3	3	1								
	5.0	Average	(Median) 887	12	0	0	0.20	14.5	10.0	0.70	4.1	88	1		1			130	92
		Maximum	2,400	16	0	0	0.20	14.5	10.8	1.40	8	88	1		1			180	130
		Minimum	350	10	0	0	0.20	14.5	8.6	0.60	1.6	88	1		1			120	92
		No. of Samples	5	5	4	3	1	2	4	5	3	1	1		1		1	1	1
	6.0	Average	(Median) 930	18	0.67	0.02		15.0	10.1	0.68	9								
		Maximum	930	24	2	0.04		15.0	10.5	0.70	9								
		Minimum	430	14	0	0		15.0	9.7	0.66	9								
		No. of Samples	3	3	3	3		2	3	3	1								
	7.0	Average	(Median) 380	16	0.50	0.02	0.10	15.0	9.9	1.16	4.8	88	1		1			155	110
		Maximum	4,300	29	2	0.04	0.10	15.0	11.0	2.40	8	88	1		1			180	150
		Minimum	43	11	0	0	0.10	15.0	8.6	0.44	2.1	88	1		1			130	66
		No. of Samples	5	5	4	3	1	2	4	5	3	1	1		1		1	2	2

Table 22.—SUMMARY OF AVERAGE ANALYTICAL RESULTS—LAKE ERIE (continued)

Sampling Range & Location	Station (miles)		Coliforms MPN per 100 ml	Chlorides ppm	Phenols ppb	Ammonia as N ppm	[illegible] ppm	Temp. °C	D.O. ppm	B.O.D. 5-day ppm	Turbidity ppm	Alk. ppm	Threshold Odor Test: Raw No.	Raw Descr.	Chlorinated No.	Chlorinated Descr.	Taste	Total Solids ppm: Total	Total Solids ppm: Volatile
	6.0	Average	(Median) 230	18	2.3	0.05		15.0	10.5	0.97	11								
		Maximum	6,500	19	7	0.04		15.5	11.0	1.10	11								
		Minimum	23	17	0	0		14.5	10.0	0.85	11								
		No. of Samples	3	3	3	3		2	3	3	1								
E-F. Detroit River East	9.0	Average	(Median) 70	15	3	0.07	0.1	15.0	10.4	1.51	6.0	84	1		1			150	100
Channel Outer Bay to		Maximum	430	18	13	0.08	0.1	15.0	11.3	2.00	13	84	1		1			170	140
Middle Sister Isl. (Cont'd)		Minimum	23	13	0	0	0.1	15.0	9.2	0.95	1.0	84	1		1			130	60
		No. of Samples	5	5	4	3	1	2	4	5	3	1	1		1		1	2	2
	10.0	Average	(Median) 39	19	0	0		14.8	10.8	1.10	13								
		Maximum	75	26	0	0		15.0	11.1	1.20	13								
		Minimum	< 3.6	12	0	0		14.5	10.6	1.00	13								
		No. of Samples	3	3	3	3		2	3	3	1								
	11.0	Average	(Median) 43	27	0	0	0.05	15.2	10.2	1.35	4.6	88	1		1			140	77
		Maximum	240	34	0	0	0.05	15.5	10.8	2.0	11	88	1		1			170	130
		Minimum	4	12	0	0	0.05	15.0	8.8	0.76	1.7	88	1		1			110	24
		No. of Samples	5	5	4	3	1	2	4	5	3	1	1		1		1	2	2
	12.0(?)	Average	(Median) 13	16	1	0.003	0.13	15.6	9.6	1.74	3.8	86	2		1			135	83
		Maximum	240	25	6	0.01	0.20	16.0	11.0	5.6	11	86	3		1			150	110
		Minimum	4.5	10	0	0	0.10	15.0	7.6	0.6	1.1	85	1		1			130	100
		No. of Samples	7	6	6	3	3	2	6	7	4	2	3		3		3	3	3
G-F. Colchester Reef Light	17.0	Average	(Median) 9.2	17	3	0	0.08	20.0	9.4	1.6	2.6	87	3		1			125	76
to Middle Sister Isl.		Maximum	< 23	23	10	0	0.15	25.0	10.9	2.0	6	87	4		1			140	96
		Minimum	< 1.8	14	0	0	0.1	15.0	8.0	1.2	1.1	87	1		1			110	56
		No. of Samples	4	5	4	2	2	2	4	5	4	1	2		2		2	2	2
	20.0	Average	(Median) 2.8	16	4	0.003	0.15	20.0	9.1	1.1	3.8	87	1		1			125	63
		Maximum	< 23	21	8	0.08	0.20	25.0	11.0	1.8	8	87	1		1			130	70
		Minimum	< 1.8	12	0	0.006	0.10	15.0	7.8	1.0	0.9	87	1		1			120	56
		No. of Samples	5	5	4	2	2	2	4	5	4	1	2		2		2	2	2
	21.0	Average	(Median) 23	14	4	0	0.15	25.0	8.4	1.3	3.2	86	2		1			200	60
		Maximum	23	16	8	0	0.20	25.0	9.0	1.8	8	86	3		1			260	70
		Minimum	< 1.8	10	0	0	0.10	25.0	7.4	0.4	1.2	85	1		1			140	50
		No. of Samples	4	4	3	1	2	1	3	4	4	1	2		2		2	2	2
S-E. Stony Point to Outer	4.5	Average	(Median) 3,500	25	3	0.01		6.0	10.8	1.37	27								
Bay on Detroit River West		Maximum	4,600	28	5	0.01		10.0	12.4	1.5	31								
Channel.		Minimum	2,400	23	0	0		0	9.3	1.2	10								
		No. of Samples	2	3	3	3		2	3	3	3								
	6.0	Average	(Median) 5,300	27	9	0.05		6.2	10.2	1.79	20								
		Maximum	11,000	37	18	0.26		16.5	13.2	2.4	28								
		Minimum	430	20	7	0		0	9.0	1.3	13								
		No. of Samples	3	3	3	3		2	3	3	3								

Table 22 —SUMMARY OF AVERAGE ANALYTICAL RESULTS— LAKE ERIE (continued)

Sampling Range & Location	Station (Miles)		Coliforms M.P.N. per 100 ml	Chlorides ppm	Phenols ppb	Amm. as N ppm	Other Nitr. ppm	Temp. °C	D.O. ppm	B.O.D. 5-day ppm	Turbidity ppm	Alk. ppm	Threshold Odor Cold				Taste	Total Solids ppm	
													Raw		Chlorinated			Total	Volatile
													No.	Nature	No.	Nature			
	7.4	Average	(Median) 1,700	26	3.7	0.05		6.2	10.9	1.47	19								
		Maximum	2,400	37	10	0.28		16.5	13.4	2.60	25								
		Minimum	930	20	0	0		0	9.2	1.10	18								
		No. of Samples	3	3	3	3		3	3	3	3								
S.E. Leamington Municipal Pier to Pelee Point Life Saving Station.	0* (L)	Average	(Median) 4,600	16	0	0.005		25.0	8.1	1.13	8.4								
		Maximum	> 24,000	16	0	0.01		25.0	8.5	1.30	9								
		Minimum	4,600	16	0	0		25.0	7.8	1.20	8								
		No. of Samples	2	2	2	2		2	2	2	2								
	0.5	Average	(Median) 2,400	16	0	0		25.0	8.6	1.29	8								
		Maximum	> 24,000	16	0	0		25.0	8.6	1.40	9								
		Minimum	2,400	15	0	0		25.0	8.5	1.10	7								
		No. of Samples	2	2	2	2		2	2	2	2								
	1.0	Average	(Median) 2,900	16	0	0		25.2	8.5	0.76	7								
		Maximum	4,600	17	0	0		25.5	8.5	1.0	7								
		Minimum	430	15	0	0		25.0	8.5	0.52	7								
		No. of Samples	2	2	2	2		2	2	2	2								
	2.0	Average	(Median) 5,500	16	0	0		25.0	8.7	1.01	6.5								
		Maximum	11,000	16	0	0		25.5	8.8	1.2	8								
		Minimum	93	16	0	0		24.5	8.6	0.80	5								
		No. of Samples	2	2	2	2		2	2	2	2								
	3.0	Average	1,200	16	0	0		25.0	8.4	0.61	7								
		Maximum	2,400	16	0	0		25.5	8.4	1.00	8								
		Minimum	43	15	0	0		24.5	8.3	0.20	6								
		No. of Samples	2	2	2	2		2	2	2	2								
	4.0	Average	1,200	15	0	0		24.5	8.6	1.08	6								
		Maximum	2,400	15	0	0		24.5	8.7	1.50	7								
		Minimum	43	15	0	0		24.5	8.6	0.66	5								
		No. of Samples	2	2	2	2		2	2	2	2								
	5.0	Average	(Median) 1,200	16	0	0		25.0	8.6	0.99	6.5								
		Maximum	2,400	16	0	0		25.5	8.8	1.10	7								
		Minimum	9.1	15	0	0		24.5	8.5	0.80	6								
		No. of Samples	2	2	2	2		2	2	2	2								
	6.0	Average	(Median) 23	15	5	0		25.0	8.5	0.60	7								
		Maximum	43	15	10	0		25.5	8.5	0.70	8								
		Minimum	23	15	0	0		24.5	8.5	0.48	6								
		No. of Samples	2	2	2	2		2	2	2	2								
	7.0	Average	(Median) 430	16	0	0		25.0	8.6	0.87	6.5								
		Maximum	930	15	0	0		25.5	8.6	1.10	7								
		Minimum	43	16	0	0		24.5	8.5	0.64	6								
		No. of Samples	2	2	2	2		2	2	2	2								

Table 22 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – LAKE ERIE (continued)

Sampling Range & Location	Station (Miles)		Coliforms M.P.N. per 100ml	Chlorides ppm	Phenols ppb	Amm. as N ppm	Chlor. Dem. ppm	Temp. °C	D.O. ppm	B.O.D. 5-day ppm	Turbidity ppm	Alk. ppm	Threshold Odor No.				Taste	Total Solids ppm	
													Raw		Chlorinated				
													No.	Descr.	No.	Descr.		Total	Volatile
	8.0	Average	(Median) 16	16	3.5	0		25.0	8.8	0.80	7.5								
		Maximum	23	17	7	0		25.5	8.9	0.90	8								
		Minimum	9.1	16	0	0		24.5	8.6	0.70	7								
		No. of Samples	2	2	2	2		2	2	2	2								
S-E. Leamington Municipal	9.0(?)	Average	(Median) 31	16	0	0		24.8	8.8	1.75	6	90						151	55
Pier to Pelee Point Life		Maximum	110	18	0	0		25.0	10.0	4.80	7	90						160	64
Saving Station. (Cont'd).		Minimum	3.6	15	0	0		24.5	8.2	0.44	1.7	88						150	54
		No. of Samples	7	7	7	5		4	5	7	7	2						2	2
S-E. Lighthouse Point Pelee	9'	Average	(Median) 14	18	0					0.70	5.4	88						175	56
Island to Pelee Point Life		Maximum	14	21	0					1.40	7.5	88						190	60
Saving Station.		Minimum	13	15	0					0.40	3.3	87						160	50
		No. of Samples	2	2	2					2	2	2						2	2
	0.5	Average	(Median) 6.4	18	0	0		24.5	8.8	0.87	11								
		Maximum	9.1	21	0	0		24.5	9.2	0.80	20								
		Minimum	< 3.6	16	0	0		24.5	8.5	0.50	6								
		No. of Samples	3	3	3	3		3	3	3	3								
	2.0	Average	(Median) 3.2	20	0					1.6	5.0	85						170	54
		Maximum	4.5	22	0					1.6	7.5	88						180	78
		Minimum	2	17	0					1.6	2.5	82						159	36
		No. of Samples	2	2	2					2	2	2						2	2
	2.5	Average	(Median) 6.2	17	7	0		25.0	8.9	0.80	7.3								
		Maximum	9.1	18	13	0		25.0	9.6	1.5	11								
		Minimum	< 3.6	15	6	0		25.0	8.4	0.54	5								
		No. of Samples	3	3	3	3		2	3	3	3								
	4.0	Average	(Median) 1.9	18	0					1.90	6.2	87						150	51
		Maximum	2	21	0					2.00	10.2	88						160	60
		Minimum	1.8	16	0					1.80	2.2	86						140	42
		No. of Samples	2	2	2					2	2	2						2	2
	4.5	Average	(Median) < 3.6	16	0	0		24.7	8.9	0.68	6.7								
		Maximum	15	16	0	0		25.0	9.9	0.70	9								
		Minimum	< 3.6	16	0	0		24.5	8.4	0.66	5								
		No. of Samples	3	3	3	3		4	3	3	3								
	6.5	Average	(Median) 3.6	15	0	0		25.0	9.1	0.85	7.7								
		Maximum	23	15	0	0		25.5	9.9	1.10	11								
		Minimum	3.6	14	0	0		24.5	8.5	0.72	6								
		No. of Samples	3	3	3	3		2	3	3	3								
S-E. River Raisin Channel	11.5	Average	(Median) 43	25	3	0.032	0.15	21.1	9.0	2.12	5.4	84	6.7					150	78
outer Buoy to River Raisin		Maximum	930	36	8	0.05	0.15	24.5	10.5	3.40	10	86	6.7		1			170	90
Turning basin.		Minimum	21	17	0	0.005	0.15	15.5	7.6	0.84	2.2	84	6.7		1			140	66
		No. of Samples	6	6	6	3	3	3	4	5	4	3	3		3		3	8	8

Table 22 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – LAKE ERIE (continued)

Sampling Range & Location	Station (miles)		Coliforms [illegible]	Chlorides ppm	Phenols ppb	Amm. as N ppm	[illegible] ppm	Temp. °C	D.O. ppm	B.O.D. 5-Day ppm	Turbidity ppm	Alk. ppm	Threshold Odor [illegible]				Taste	Total Solids ppm	
													Raw		[illegible]				
													No.	[illegible]	No.	[illegible]		Total	Volatile
	12.5	Average	(Median) 670	39	3	0.027	0.15	21.3	8.9	2.11	6	89	6.7		1			160	75
		Maximum	1,700	39	8	0.04	0.15	24.5	10.2	4.60	10	89	6.7		1			180	100
		Minimum	11	38	0	0.004	0.15	16.8	8.0	0.70	1.6	89	6.7		1			140	50
		No. of Samples	5	5	5	3	1	3	4	5	4	1	1		1		1	2	2
	13.5	Average	(Median) 93	38	2.4	0.018	0.15	21.3	8.4	1.84	7.2	98	5		1			190	82
		Maximum	4,300	39	10	0.03	0.15	24.5	9.8	3.6	13	98	5		1			200	98
		Minimum	21	36	0	0	0.15	15.5	8.0	0.58	1.8	98	5		1			180	66
		No. of Samples	5	5	5	3	1	3	4	5	4	1	1		1		1	2	2
	14.5	Average	(Median) 230	37	6	0.023	73	21.3	8.4	1.47	9	189	14		6.7			199	130
		Maximum	16,000	38	30	0.06	73	24.5	9.5	2.60	29	189	14		6.7			220	170
		Minimum	40	37	0	0	73	15.5	7.5	0	2.1	189	14		6.7			170	90
		No. of Samples	5	5	5	3	1	3	4	5	4	1	1		1		1	2	2
D-F. River Raisin Channel	14.6	Average	(Median) 9,300	14	6	0.03		21.0	4.0	4.1	38								
Outer Bay to River Raisin		Maximum	46,000	18	10	0.09		26.0	8.5	5.8	39								
Turning basin. (Cont'd).		Minimum	9,300	9.2	0	0		15.5	1.4	>1.4	37								
		No. of Samples	3	3	3	3		3	3	3	2								
	16.5(P)	Average	(Median) 110,000	16	35	0.005		25.0	1.1	6.2	33								
		Maximum	>240,000	18	70	0.01		26.0	2.2	6.2	37								
		Minimum	110,000	14	0	0		24.0	0	6.2	29								
		No. of Samples	2	2	2	2		2	2	1	2								
D-F. River Raisin Channel	12.5	Average	(Median) 28	13	1.5	0.02	0.10	19.5	9.2	1.89	3.6	84	1		1			125	74
Outer Bay to Middle		Maximum	930	18	6	0.08	0.10	24.0	10.1	3.00	7	84	1		1			130	88
Sister Island.		Minimum	23	9.7	0	0	0.10	15.0	8.4	0.85	1.7	84	1		1			120	60
		No. of Samples	4	4	4	4	2	1	2	3	4	3	1		1		1	2	2
	14.5	Average	(Median) 86	11	1.5	0.03		19.5	9.2	1.58	5.4		2		1			110	70
		Maximum	150	12	6	0.1		24.0	10.5	3.40	9		2		1			110	70
		Minimum	4.5	10	0	0		15.0	8.6	0.76	1.9		2		1			110	70
		No. of Samples	4	3	4	3		2	3	4	2		1		1		1	1	1
	16.5	Average	(Median) 73	14	2	0	0.10	19.5	9.1	1.13	3.3	88	1		1			120	60
		Maximum	240	18	8	0	0.10	24.0	10.0	1.4	6	88	1		1			140	72
		Minimum	< 1.8	9.1	0	0	0.10	15.0	8.0	1.0	1.7	88	1		1			100	52
		No. of Samples	4	4	4	2	1	2	3	3	3	1	1		1		1	2	2
	18.5	Average	(Median) 23	12	1.5	0	0.10	19.8	9.2	1.12	2.8	86	1		1			114	68
		Maximum	33	17	6	0	0.10	24.5	10.0	1.60	5	86	1		1			140	70
		Minimum	< 1.8	9.8	0	0	0.10	15.0	8.2	0.70	1.2	86	1		1			88	66
		No. of Samples	4	4	4	2	1	2	3	4	3	1	1		1			2	2
	20.5	Average	(Median) 23	13	1.5	0.005	0.10	19.8	9.3	1.08	2.6	88	5		1			120	70
		Maximum	44	17	6	0.01	0.10	24.5	10.9	1.20	5	88	5		1			140	70
		Minimum	< 1.8	9.9	0	0	0.10	15.0	8.0	0.98	1.1	88	5		1			100	70
		No. of Samples	4	4	4	2	1	2	3	4	3	1	1		1		1	2	2

Table 22 — SUMMARY OF AVERAGE ANALYTICAL RESULTS - LAKE ERIE (continued)

Sampling Point & Location	Station (Miles)		Coliforms MPN per 100 ml	Chlorides ppm	Phenols ppb	Ammonia as N ppm	Chlorine Demand ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm	Turbidity ppm	Alk. ppm	Threshold Odor, Cold: Raw No.	Raw Nature	Chlorinated No.	Chlorinated Nature	Taste	Total Solids ppm: Total	Volatile
	20.5	Average	(Median) 3.6	12	0	0		19.6	9.8	0.82	6								
		Maximum	3.6	13	0	0		24.5	10.8	0.88	6								
		Minimum	<3.6	10	0	0		15.0	8.9	0.86	6								
		No. of Samples	2	2	2	2		2	2	2	1								
S-S-E, Toledo Harbor Light to West Sister Island to Niagara Reef Buoy.	1.0	Average	(Median) 120	24	0		0.15		9.0	2.0	23	100	2		1			210	82
		Maximum	240	26	0		0.15		9.0	2.6	45	110	2		1			230	84
		Minimum	6.5	23	0		0.15		9.0	1.4	1.4	90	2		1			190	80
		No. of Samples	2	2	1		1		1	2	2	2	1		1		1	1	1
	3.0	Average	(Median) 91	24	0	0.015		17.2	10.6	1.20	11								
		Maximum	91	26	0	0.03		24.0	11.2	2.0	11								
		Minimum	<3.6	22	0	0		10.5	10.0	0.50	11								
		No. of Samples	2	2	2	2		2	2	2	1								
	4.0	Average	(Median) 18	25	0		0.15		9.6	1.1	15	94	3		1			200	83
		Maximum	33	26	0		0.15		9.6	1.6	28	100	3		1			210	88
		Minimum	8	24	0		0.15		9.6	0.6	1.1	88	3		1			190	78
		No. of Samples	2	2	1		1		1	2	2	2	1		1		1	2	2
	6.0	Average	(Median) 8.0	24	2.3	0.04	0.01	17.2	9.8	1.12	10	99	1					205	92
		Maximum	150	26	7	0.08	0.01	24.5	11.1	1.80	22	99	1					230	100
		Minimum	3.6	21	0	0	0.01	10.0	8.8	0.58	1.1	88	1					180	84
		No. of Samples	4	4	3	2	1	2	3	4	3	2	1					2	2
	8.0	Average	(Median) 5.0	23	0		0.10		6.6	0.70	9.2	90	2		1			200	80
		Maximum	7.6	28	0		0.10		6.6	0.80	17	96	2		1			210	90
		Minimum	2.3	18	0		0.10		6.6	0.60	1.4	84	2		1			180	70
		No. of Samples	2	2	1		1		1	2	2	2	1		1		1	2	2
	9.0	Average	(Median) 47	20	2.5	0.03		17.8	10.0	1.00	6								
		Maximum	91	21	5	0.06		24.5	11.4	1.30	6								
		Minimum	3.6	20	0	0		10.8	8.7	0.60	6								
		No. of Samples	2	2	2	2		2	2	2	1								
	11.0(K)	Average	(Median) 4.5	19	0	0	0.10	24.5	8.6	1.27	3.5	84	2		1			160	60
		Maximum	4.5	21	0	0	0.10	24.5	9.9	1.4	6	88	2		1			180	80
		Minimum	<1.8	17	0	0	0.10	24.5	6.9	0.80	1.4	80	0		1			140	40
		No. of Samples	3	3	3	1	1	1	2	3	3	4	1		1		1	2	2
	13.0	Average	(Median) 7.8	20	0		0.10		8.8	1.20	3.5	84	2		1			170	68
		Maximum	7.8	24	0		0.10		8.8	1.40	5.5	85	2		1			190	82
		Minimum	< 1.8	16	0		0.10		8.8	1.00	1.4	83	2		1			150	54
		No. of Samples	2	2	2		1		1	2	2	2	2		1		1	2	2
	16.0	Average	(Median) 0.7	19	0		0.1		9.4	1.7	3.8	86	3		1			175	72
		Maximum	1.4	23	0		0.1		9.4	2.2	5.2	86	3		1			200	88
		Minimum	0	16	0		0.1		9.4	1.2	2.2	86	3		1			150	56
		No. of Samples	2	2	2		1		1	2	2	2	1		1		1	2	2

Table 22 — SUMMARY OF AVERAGE ANALYTICAL RESULTS — LAKE ERIE (continued)

Sampling Range & Location	Station (miles)		Coliforms M.P.N. per 100 ml	Chlorides ppm	Phenols ppb	Amm. as N ppm	[illegible] ppm	Temp °C	D.O. ppm	B.O.D. 5-day ppm	Turbidity ppm	Alk. ppm	Threshold Odor Cold				Taste	Total Solids ppm	
													Raw		Chlorinated				
													No.	Nature	No.	Nature		Total	Volatile
P-O, Middle Sister Island to	13.0	Average	240	19	16	0			10.6	1.7	9								
Niagara Reef Buoy.		Maximum	240	19	16	0			10.6	1.7	9								
		Minimum	240	19	16	0			10.6	1.7	9								
		No. of Samples	1	1	1	1			1	1	1								
	14.0	Average	(Median) 23	26	0		0.1		7.8	1.3	1.6	89	1		1			150	50
		Maximum	23	36	0		0.1		7.8	2.4	2.0	90	1		1			160	60
		Minimum	[illegible]	16	0		0.1		7.8	0.2	1.3	88	1		1			140	40
		No. of Samples	2	2	2		1		1	2	2	2	1		1			2	2
	15.0	Average	240	22	25	0			10.1	1.5	14								
		Maximum	240	22	25	0			10.1	1.5	14								
		Minimum	240	22	25	0			10.1	1.5	14								
		No. of Samples	1	1	1	1			1	1	1								
	16.0	Average	(Median) 14	18	0		0.05		8.6	1.3	1.7	86	3		1			155	56
		Maximum	23	20	0		0.05		8.6	1.4	2.4	86	3		1			160	60
		Minimum	4.5	15	0		0.05		8.6	1.2	1.0	85	3		1			150	52
		No. of Samples	2	2	2		1		1	2	2	2	1		1		1	2	2
	17.0	Average	9.1	20	0	0			10.3	1.2	13								
		Maximum	9.1	20	0	0			10.3	1.2	13								
		Minimum	9.1	20	0	0			10.3	1.2	13								
		No. of Samples	1	1	1	1			1	1	1								
	18.0	Average	(Median) 20	18	0		0.05		8.0	2.3	1.8	84	3		1			145	61
		Maximum	33	21	0		0.05		8.0	3.4	2.5	84	3		1			160	66
		Minimum	6.8	16	0		0.05		8.0	1.2	1.0	84	3		3			130	55
		No. of Samples	2	2	2		1		1	2	2	2	1		1		1	2	2
	19.0	Average		20	0	0			10.2	1.1	12								
		Maximum		20	0	0			10.2	1.1	12								
		Minimum		20	0	0			10.2	1.1	12								
		No. of Samples		1	1	1			1	1	1								
	20.0	Average	(Median) 4	17	0		0.1		8.8	1.5	2.1	96	2		1			165	64
		Maximum	4	18	0		0.1		8.8	1.6	2.9	97	2		1			170	76
		Minimum	< 1.8	16	0		0.1		8.8	1.4	1.3	94	2		1			160	52
		No. of Samples	2	2	2		1		1	2	2	2	1		1		1	2	2
	21.0	Average	3.6	18	20	0			9.1	0.53	18								
		Maximum	3.6	18	20	0			9.1	0.53	18								
		Minimum	3.6	18	20	0			9.1	0.53	18								
		No. of Samples	1	1	1	1			1	1	1								
	22.0	Average	(Median) < 1.8	20	0		0.10		8.8	1.0	4.8	91	2		1			175	63
		Maximum	< 1.8	22	0		0.1		8.8	1.2	6.7	97	2		1			180	66
		Minimum	< 1.8	18	0		0.1		8.8	0.8	2.9	85	2		1			170	60
		No. of Samples	2	2	2		1		1	2	2	2	1		1		1	2	2

Table 22 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – LAKE ERIE (continued)

Sampling Range & Location	Station (miles)		Coliforms M.P.N. per 100 ml	Chlorides ppm	Phenols ppb	[illegible] ppm	[illegible] ppm	Temp. °F	D.O. ppm	B.O.D. 5-day ppm	Turbidity ppm	Alk. ppm	[illegible]				Taste	Total Solids ppm	
													[illegible]	[illegible]	[illegible]	[illegible]		Total	Volatile
	23.0	Average	3.6	16	22	0			9.0	0.05	34								
		Maximum	3.6	16	25	0			9.0	0.05	34								
		Minimum	3.6	16	25	0			9.0	0.05	34								
		No. of Samples	1	1	1	1			1	1	1								
		Average																	
		Minimum																	
	17.0	Average	(Median) 1.7	20	0		0.1		8.8	3.0	6.0	89	4		1			180	79
		Maximum	2	20	0		0.1		8.8	6.6	9.0	92	4		1			200	96
		Minimum	1.4	17	0		0.1		8.8	1.0	2.0	87	4		1			160	62
		No. of Samples	2	2	2		1		1	2	2	2	1		1		1	2	2
	20.0(E)	Average	(Median) < 3.6	20	0	0	0.1	34.5	9.0	1.0	11	89	4		1			200	72
		Maximum	7.0	23	0	0	0.1	34.5	9.1	1.3	23	86	4		1			300	80
		Minimum	< 1.0	18	0	0	0.1	34.5	8.8	0.59	3.0	86	4		1			170	68
		No. of Samples	4	4	4	2	1	2	2	2	4	2	1		2		1	2	2
S-D. Niagara Reef Buoy to South Point Shoal Flashing Buoy.	13.0	Average	(Median) 2.3	18	2	0		33.0	8.0	0.77	15								
		Maximum	< 3.6	20	10	0		35.0	9.0	1.5	19								
		Minimum	3.0	17	0	0		33.0	8.0	0.44	11								
		No. of Samples	2	2	2	2		1	2	2	2								
	26.0	Average	(Median) 3.6	17	10	0		34.5	8.9	0.80	13								
		Maximum	3.6	17	20	0		34.5	9.0	1.1	16								
		Minimum	< 3.6	17	0	0		34.5	8.8	0.59	10								
		No. of Samples	2	2	2	2		1	2	2	2								
	28.0(E)	Average	(Median) 6.0	18	4.2	0		34.5	8.9	0.76	16								
		Maximum	43	19	10	0		34.5	9.0	0.86	20								
		Minimum	3.6	16	0	0		34.5	6.2	0.50	6								
		No. of Samples	4	4	4	4		2	4	4	4								
S-E. South Point Shoal Flashing Buoy to Pelee Isl. West Dock.	2.0	Average	(Median) 3.6	18	0	0.002		34.5	9.1	1.35	12	88						180	56
		Maximum	17	20	0	0.005		34.7	10.0	2.2	27	88						190	56
		Minimum	0	16	0	0		34.5	8.6	0.03	3.3	88						180	56
		No. of Samples	5	4	5	3		2	3	5	4	1						1	1
	4.0	Average	(Median) < 3.6	18	0	0		34.7	9.1	1.8	11	90						180	59
		Maximum	< 3.6	21	0	0		34.9	9.8	3.6	20	97						220	64
		Minimum	< 1.8	16	0	0		34.5	8.8	0.05	2.6	82						160	52
		No. of Samples	5	5	5	3		2	3	5	5	2						2	2
	6.0	Average	(Median) 13	18	2	0		34.5	9.0	1.3	11	91						180	57
		Maximum	36	24	10	0		34.5	9.6	3.6	26	93						200	58
		Minimum	1.4	16	0	0		34.0	8.6	0.41	2.0	89						160	46
		No. of Samples	5	5	5	3		2	3	5	5	2						2	2
	8.0	Average	(Median) 4.5	18	0.4	0		34.8	9.1	1.26	10	94						180	55
		Maximum	15	21	2	0		34.5	9.0	1.6	21	98						200	58
		Minimum	1.4	16	0	0		34.0	8.3	0.28	6.7	90						170	55
		No. of Samples	5	5	5	3		2	2	2	2	2						2	2

Table 22 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – LAKE ERIE (continued)

Sampling Range & Location	[illegible]		Coliform MPN	Chlorides (ppm)	Phenols (ppb)	[illegible]	[illegible]	Temp. °C	D.O. ppm	B.O.D. 5 day (ppm)	Turbidity (ppm)	[illegible]	[illegible]				[illegible]	[illegible]	
													[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
	30.0	Average	(Median) 23	25	0	0		21.0	8.1	0.67	22								
		Maximum	93	26	0	0		21.5	9.0	2.4	30								
		Minimum	< 3.6	25	0	0		21.0	6.7	0.60	7								
		No. of Samples	4	3	3	3		3	3	-	3								
	[illegible]	Average	<3.6	25	0	0		20.4	9.4	3.6	7								
		Maximum	<3.6	25	0	0		20.5	9.4	3.6	7								
		Minimum	<3.6	25	0	0		20.5	9.4	3.6	7								
		No. of Samples	1	1	1	1		1	1	1	1								

COMPARISONS - 1913 AND 1946-1948 RESULTS

In view of the fact that a number of sampling points were common to both investigations it is possible to make comparisons of the conditions then and now. Since the previous examination was essentially a bacteriological one it is feasible to compare the coliform results only. Table 23 shows some comparisons made at four significant ranges in the Lake Huron - Lake Erie section. These comparisons can be approximate only since averages were used in the 1913 survey and medians in the present one. The former tends to give greater weight to abnormal results. The B. coli index of the 1913 results has been converted to the M.P.N. index by applying the factor of 2.4 to the former.

Table 23 - AVERAGE COLIFORM RESULTS, 1913 AND 1946-1948

Location	M.P.N. per 100 ml.	
	1913	1946-1948
Lake Huron	5	5
St. Clair River Port Lambton-Roberts Landing (Range SR-13.7)	305	910
Detroit River At Peach Island (Ranges Dt-30.7e and Dt-30.8w)	8	46
At Bar Point (Range Dt-3.9)	4,220	12,200

This table reveals that the present bacterial load is three to four times greater than in 1913. At that time, the overall increase from Lake Huron to the mouth of the Detroit River was approximately 800 times as compared with a 3000-fold increase today. In spite of the sewage treatment provided in this interval the bacterial load at the outlet of the Detroit

River is about 3 times greater than in 1913.

SUPPLEMENTARY INFORMATION ON POLLUTION EFFECTS

While the effects of pollution on these boundary waters is revealed chiefly by the analytical results on samples collected during the survey, supplementary material has been obtained from various sources. All this information has been studied in an effort to evaluate the effects of pollution.

Municipal Water Supplies

Special studies were made during this investigation to evaluate any public health threat or burden placed by pollution on the public water supplies of the communities bordering on the boundary waters. The specific nature as well as the extent of this pollution was studied. The procedure included routine sampling and analysis of the raw waters by the field staffs, and review of purification plant records for the years 1942-1947, inclusive. These activities were concentrated at the major water plants located in the Lake Huron - Lake Erie section. The plants were selected to show local conditions and also progressive changes in water quality from the upper to the lower reaches.

A summary of the analytical results of raw water samples collected by the field staffs is given in table 24. At five plants, taking water from the St. Clair River and Lake St. Clair, the median numbers of coliform bacteria varied from a minimum of 92 to a maximum of 930 per 100 ml. For the same five plants, however, individual samples varied from a low of 2 to a high of 35,000 M.P.N. These extremes are more indicative of the problems associated with purification of the water reaching these intakes than are the median values.

The coliform results of the raw water samples taken at the Detroit plant show a median coliform number of 4.5 and a maximum of 2,400 per 100 ml. The quality of this supply is due to the location of the intake structure at the head of Belle Isle. This intake is beyond the normal zone of shore pollution, and it receives water which has been subjected to sedimentation and other natural purification processes in passing through Lake St. Clair. It is, however, subject to the influence of wind conditions, unusual currents, and other related factors.

At Wyandotte and Trenton, taking water from the lower Detroit River, the median coliform numbers were each 15,000 per 100 ml. The concentration of pollution at these intake locations is shown by corresponding high maximum M.P.N. indices of 163,000 and 46,000, respectively.

The other laboratory analyses listed in table 24 tend to confirm the intensity of pollution and variable quality as indicated by the bacteriological results.

Table 24. SUMMARY OF ANALYTICAL RESULTS FOR MUNICIPAL INTAKE SAMPLES
I.J.C. Field Data, 1946-1948

Municipality	Mileage Index No.		Coliforms M.P.N. per 100 ml.	Chlorides ppm	Phenols ppb	Amm. as N_2 ppm	Chlor. Dem. ppm	D.O. ppm	B.O.D. 5 day ppm	pH	Alkalinity ppm	Turbidity ppm	Odor-Cold Threshold No.
Marysville	SR-31.2	Median	130										
		Average		6.0	1	0.46				7.4	82		4.8
		Maximum	1,200	11	4	0.48				7.7	86		16
		Minimum	19	3.9	0	0				7.0	78		2
		No. of Samples	23	8	8	8				8	8		8
St.Clair	SR-25.5	Median	320										
		Average		5.8	1	0.16	0.7			7.3	79		5
		Maximum	1,300	7.8	2	0.42	1.1			7.6	84		16
		Minimum	190	2.6	0	0	0.6			6.9	74		2
		No. of Samples	18	6	6	6	6			6	6		6
Marine City	SR-17.7	Median	790										
		Average		10	2	0.03	0.49	11.1	1.0	7.6	81	13	1
		Maximum	35,000	20.7	78	0.46	2.39	13.1	3.7	8.1	91	67	4
		Minimum	49	6.1	0	0	0.5	6.30	0	7.0	27	3	0
		No. of Samples	153	38	48	29	44	29	30	38	38	16	33

Table 24. SUMMARY OF AVERAGE ANALYTICAL RESULTS FOR MUNICIPAL INTAKE SAMPLES (continued)

Municipality	Mileage Index No.		Coliforms M.P.N. per 100 ml.	Chlorides ppm	Phenols ppb	Amm. as N_2 ppm	Chlor. Dem. ppm	D.O. ppm	B.O.D. 5-day ppm	pH	Alkalinity ppm	Turbidity ppm	Odor-Cold Threshold No.
Mt.Clemens	Lake St. Clair Range SW-4.2	Median	930										
		Average		9.4	8	0.14	0.43	11.1	1.4	7.6	94	38	3.5
		Maximum	18,000	32	264	0.5	1.35	13.3	13.0	8.7	130	122	16
		Minimum	<32	5.1	0	0	0.23	6.2	0.1	6.6	46	8	0
		No. of Samples	183	72	97	66	57	58	62	72	72	20	58
Grosse Pte. Farms	Lake St. Clair Range I-II-4.0	Median	92										
		Average		8.0	2	0.03	0.38	11.3	1.8	7.6	85	41	1.0
		Maximum	16,000	16	22	0.40	0.80	13.8	2.6	8.0	99	43	10
		Minimum	1.9	5.0	0	0	0.19	6.0	0.3	7.3	76	2	0
		No. of Samples	144	34	49	28	37	28	28	35	36	9	37
Detroit	Dt-29.2	Median	4.5										
		Average		7.3	1.0	0.03	0.30	11.0	0.63	7.6	83	11	1
		Maximum	2,400	27	30	0.46	0.95	13.8	2.2	8.5	100	75	4
		Minimum	0.63	4.7	0	0	0.10	5.8	0	7.3	74	2	0
		No. of Samples	441	73	98	60	74	76	77	73	73	29	72

Table 24. SUMMARY OF AVERAGE ANALYTICAL RESULTS FOR MUNICIPAL INTAKE SAMPLES (continued)

Municipality	Mileage Index No.		Coliforms M.P.N. per 100 ml.	Chlorides ppm	Phenols ppb	Amm. as N_2 ppm	Chlor. Dem. ppm	D.O. ppm	B.O.D. 5-day ppm	pH	Alkalinity ppm	Turbidity ppm	Odor-Cold Threshold ppm
Wyandotte	Dt-14.6	Median	15,000										
		Average		19	5.9	0.05	0.39	10.9	2.0	7.6	82	13	3
		Maximum	163,000	90	50	0.50	0.80	13.14	8.0	8.0	100	55	20
		Minimum	4,300	5.9	0	0	0.3	6.1	0	7.3	80	5	0
		No. of Samples	220	55	75	39	36	58	62	47	47	33	35
Trenton	Dt-9.5	Median	15,000										
		Average		69	33			12.0	6.6	8.3	93		5
		Maximum	46,000	96	76			13.5	9.1	9.2	110		16
		Minimum	910	26	0			9.2	2.2	7.5	84		0
		No. of Samples	35	12	12			11	12	12	12		12

The operations and laboratory records of six major water purification plants were reviewed to ascertain what changes took place in the quality of the raw water supplies over a more extended period. Emphasis was given to taste and odor troubles. The history in the plants revealed sporadic occurrences during the past 20 years. Not until early in 1944, however, did the intensity and characteristics of the tastes and odors become major problems in waterworks using the boundary waters as sources of supply.

Coliform results from the plant laboratory records for 1942-1947 are summarized in table 25. These data show relatively high coliform numbers in the raw water at Marine City, taking water from the St. Clair River, and at Mt.Clemens, from the upper Lake St. Clair. Marine City average coliform results, on water taken through a relatively short intake, are higher than those for Mt. Clemens. They reflect the influence of shore pollution from upstream communities. Although the yearly average results at Mt. Clemens decreased from 1942 to 1947, the variation in the quality, as indicated by the high maximum values, showed no corresponding reduction. The variation in the discharge of sewage pollution from the Clinton River, located a few miles above this waterworks intake, appears to be primarily responsible for these high maximum coliform counts.

The effects of the natural purification agencies in Lake St. Clair are evident from the lower coliform numbers in the raw water supplies of Grosse Pointe Farms and Highland Park. These two plants take water from a common intake point, located 2,500 feet offshore, approximately midway between the mouth of the Clinton River and the head of the Detroit River. Still lower numbers of coliform bacteria are found in the raw water received at Detroit. This further demonstrates the beneficial effects of detention and dilution taking place in Lake St. Clair.

The water taken by Wyandotte from the lower Detroit River has the highest coliform number of any public water supply located on these boundary waters. This is not surprising since the intake is located below discharges from the concentrated industrial areas and sewer outlets in the Detroit and Rouge Rivers, and, because of a break in the intake line, water is drawn from the zone of gross shore pollution. Similar water quality prevailed at the downstream city of Trenton, Michigan, which condition forced the abandonment, in 1943, of that supply in favor of service from the Detroit system.

Table 25. SUMMARY OF COLIFORM RESULTS, IN M.P.N. PER 100 MILLILITERS
Data from plant laboratory records

Municipality	Marine City	Mt. Clemens	Grosse Pointe Farms	Highland Park	Detroit	Wyandotte
Source of Supply / Year	St.Clair R.	L. St.Clair	L. St.Clair	L. St.Clair	Upper Detroit R.	Lower Detroit R.
1942 Yearly Aver. Max. Daily Aver.	3,394 24,000	3,295 240,000	762 -	504 -	97 237	19,678 240,000
1943 Yearly Aver. Max. Daily Aver.	4,475 24,000	3,385 240,000	569 -	700 -	201 1,102	16,120 240,000
1944 Yearly Aver. Max. Daily Aver.	1,576 11,000	719 24,000	304 24,000	316 13.265	60 144	21,155 1,100,000
1945 Yearly Aver. Max. Daily Aver.	2,167 11,000	510 >24,000	226 4,600	290 7,800	115 350	21,627 1,000,000
1946 Yearly Aver. Max. Daily Aver.	5,128 11,000	1,622 240,000	456 11,000	740 8,350	212 1,196	23,657 1,110,000
1947 Yearly Aver. Max. Daily Aver.	5,029 11,000	1,107 110,000	416 4,600	800 10,765	100 710	24,885 110,000

Tastes and odors have been irritating problems in the municipal water supplies of this section. Reliable records are not available over a period of years. Routine tests were run on few of the raw supplies prior to 1945, reliance being placed on the presence or absence of tastes in the treated water and on consumer complaints.

It is known that tastes and odors have been present in the raw water sporadically for several years. In most cases the treatment plants were successful in coping with this problem. In early 1944, tastes in the chlorinated water became more frequent and more persistent. Such condition was acute in the period 1944 to 1947. This would indicate either an increased intensity of taste producing substances or the introduction of new compounds. The situation became so pronounced that it was an important factor in prompting this investigation.

In the St. Clair River and Lake St. Clair area tastes have been reported in most water supplies, with the exception of Port Huron and Sarnia. They have been more acute at Marine City, Mt. Clemens, and Detroit on the United States side. On the Canadian side all water supplies below Sarnia have experienced tastes. Worst conditions occurred at Wallaceburg in February 1946.

At Mt. Clemens, the first specific occurrence of chlorophenolic tastes was recorded in January 1944. During the remainder of that year and for 1945 and 1946 no such tastes were reported on the finished water. In January and March 1947 severe tastes were reported again. Faint tastes were noted in December 1947 and unusually severe tastes in January and February 1948. Routine taste tests on the chlorinated raw water were instituted at this plant in January 1948. No methods of taste control tried there have as yet proved completely effective. A review of data from the Mt.Clemens water filtration plant, which has its source of supply located in Lake St. Clair about five miles below the mouth of the Clinton River, indicates a close association between the diversion of storm flows into Red Run and Clinton River and water treatment difficulties at this plant.

In Detroit, the first major taste occurrence in the chlorinated raw water was experienced in May 1944. During the balance of that year there were occurrences of chlorophenolic tastes on 76 days, ranging from very faint to strong. Sixteen of these were reported as strong or definite. For 1945, out of 43 days of reported occurrences, 9 were strong or definite. In 1946 tastes were noted on 47 days, of which 12 were strong or definite. The total occurrences in 1947 were 13 days, with 3 of these being strong or definite. In 1948 the total was 9, of which 6 were strong or definite. Four of these strong tastes, in early December 1948, coincided with an accidental spill of phenol in the St. Clair River.

In Windsor, a very objectionable medicinal taste occurred in December 1930 in the water supplied to the consumers. In July 1937 and April 1940 similar tastes were noted. Some evidence of taste was detected in 1944, coincident with the Detroit experience, but the chloramine treatment was effective in reducing this taste to an acceptable degree. No taste occurrences in the treated water were reported in 1945. Routine tests on chlorinated raw water were not developed to a satisfactory point until late in 1945. Taste occurrences in 1946 totalled 8, of which 2 were more persistent. On February 20th a taste occurrence was common to both Detroit and Windsor. Wind directions on the 19th were E-NE and on the 20th were W-NW. This taste was preceded by a severe occurrence at Wallaceburg on February 15. In 1947, Windsor reported eight taste occurrences in February and March, one of which was a trace only. In 1948, the total was 6 , all of which occurred in December, about a week later than the tastes at Detroit.

These records reveal that a greater number of taste occurrences were reported at Detroit than at Windsor. The number of such instances has declined, in Detroit, from a high of 76 in 1944 to a low of 9 in 1948.

In the lower Detroit River the records are not specific or complete, but it is known that frequent taste occurrences have been experienced for many years at Wyandotte and to a lesser extent at Amherstburg.

Taste Examinations of Boundary Waters

In 1946, prior to this investigation, three taste surveys were made by water works officials of Detroit and Windsor. These studies were precipitated by the onset of tastes and odors in the Detroit water supply. This involved sampling of the waters of Lake St. Clair and St. Clair River to Sarnia and Port Huron. The water was first chlorinated and then examined for chlorophenolic tastes. It was found that tastes were traceable through Lake St. Clair and the Chenal Ecarte into the upper St. Clair River.

A special taste study was also undertaken by the field staffs on September 25 and 26, 1946 in connection with a taste occurrence at the Detroit water works. Samples were taken of the river and lake waters at various points, beginning at the Detroit intake lagoon at the head of Belle Isle and proceeding upstream as far as Port Huron and Sarnia. It was found that tastes were detectable at this time in the lake and into the upper St. Clair River.

Bathing Beaches

Since 1932, when the Michigan Stream Control Commission made a coastline pollution survey of the waters on the United States side from Lake Huron to Lake Erie, it has been generally known that these waters are either questionable or unsuitable for swimming. Periodic water tests and sanitary surveys at the organized bathing areas show the sanitary quality of the waters to be highly variable. This is influenced by many conditions such as wind, water currents, combined sewer overflows, and inadequate sanitary facilities. During more recent years the local health authorities have attempted some control over bathing beaches in their respective jurisdictions. The public demand, however, has dictated a less drastic action than the complete prohibition of these waters for swimming.

The Grosse Pointe communities, which maintain municipal beaches along the westerly shore of Lake St. Clair, have similarly recognized the danger of using the lake waters indiscriminately. The results on daily samples collected at the municipal beach of Grosse Pointe Farms may be taken as indicative of the water quality at this area. Using an M.P.N. index of 2,400, adopted by the Great Lakes Board of Public Health Engineers and recognized by others as the upper limit of tolerable bacterial pollution for bathing waters, it was found that this value was exceeded 19 percent of the time during the season of June, July, and August 1948. These coliform results, combined with the known presence of pollution from adjacent sources, resulted in closing the beaches to bathers for a total of seven days during that summer season.

To insure protection for its citizens, Grosse Pointe Park has enclosed an area in the lake with a concrete wall and maintains chlorination of the confined waters. Tests of this water have consistently shown low coliform concentrations, but this degree of protection has involved the spending of a considerable sum of public funds for the initial structure and for operation and maintenance.

There are numerous bathing areas spotted along the west shore of Lake St.Clair from Point Huron to Gaukler Point. The cluster of bathing beaches located within the immediate vicinity of the Nine Mile Drain has been of concern to local health authorities. Heavy shore pollution is indicated in tests made by the Macomb County Health Department during the summer of 1948. Samples at four local beaches showed high or excessive coliform numbers at two of the beaches in 50 percent of the samples taken, and water at the other two beaches unsuitable for bathing 30 percent and 25 percent of the time, respectively. These beaches were closed during the summer of 1946 but were opened the following seasons, subject to control by the local health officer. Epidemiological data in regard to local water-borne diseases are meager. Case histories of some typhoid patients in the city of Detroit in 1944 pointed strongly to infections contracted at the beaches adjacent to the Nine Mile Drain.

Pollution of the waters along the shores of the Detroit River has been demonstrated over a number of years. In 1941, the first action which recognized the unsuitability of the bathing waters surrounding Bois Blanc Island resulted in the voluntary closing of that beach. In 1944, the city of Detroit, by ordinance, prohibited swimming along its entire waterfront. The condition of these waters left no alternative. In spite of this voluntary action and prohibiting regulation there is considerable swimming in the Detroit River. During the hot summer days many persons, who do not have access to clean and safe swimming facilities, use these waters with complete disregard of the proximity of sewer outlets and industrial waste drains.

There remain at present only two recognized bathing beaches in the Detroit River. One beach is located on the west shore of Belle Isle. The other is in the same locality on the Canadian shore. Sanitary control has been exercised over the Belle Isle beach by the Detroit Health Department since 1925. The coliform numbers, reported as Phelps Index, show a yearly median of less than 100 organisms per 100 ml. Occasional maxima of 1000 for individual samples have been reported.

Although the waters at the Belle Isle beach have been relatively free of bacterial pollution there have been occasions when the beach was closed to bathers. Pollution in the form of floating oil and sludge has crossed the channel, under certain wind conditions, from the mouth of Conner Creek, opposite Belle Isle on the United States shore. This beach has been closed for periods averaging five to seven days each season.

Fish and Wild Life

The effects of pollution are further revealed in many reported cases of the destruction of fish and ducks. This has been attributed to the presence of chemical poisons and oils. These occurrences have been most common in the lower Detroit River area.

Detroit Sewage Treatment Plant

In the evaluation of pollution it was necessary to determine what effect the sewage treatment plant of the city of Detroit has had upon the boundary waters. The significance of this plant is apparent when it is considered that it receives the wastes from a population of 2,200,000 and discharges an average of 350 M.G.D. (U.S.) of partially treated sewage into a part of the Detroit River already burdened by domestic and industrial wastes entering from upstream sources and from the Rouge River.

The information for this study was derived from an analysis of operating records of the Detroit sewage treatment plant, phenol tests of plant influent and effluent by the field staffs, and analytical results on river samples. Emphasis was placed on a comparison of the bacteriological quality of the river water before and after the installation of these works in 1940.

The Detroit plant effluent contained an average coliform concentration of 1,210,000 M.P.N. per 100 ml., based on 1946 and 1947 operating records. Other constituents in the effluent averaged; suspended solids 99 p.p.m., volatile suspended solids 70 p.p.m., ammonia (limited records) 18 p.p.m., and B.O.D. 63 p.p.m. The plant removed 55 percent of the suspended solids and 46 percent of the B.O.D. Chlorination satisfied 63 percent of the chlorine demand of the final effluent. It was necessary to suspend chlorination for 10 percent of this time because of slugs of pickling liquor. The operating policy was to satisfy 100 percent of the chlorine demand in the summer months and 60 percent for the rest of the year. It was stated to be difficult to maintain this policy because of the rapid fluctuation in chlorine demand and the variable flow rates.

Special phenol studies were conducted by the field staffs during the period of May 2 to 10, 1949. Analyses were made on samples collected at 30 minute intervals and composited at 3 hours and 24 hours. The average 24-hour phenol figure for the effluent was 150 p.p.b. when all known sources of phenol were contributing, including South Eastern Oakland County pumping station. Maximum values occurred between 6 and 9 A.M. each day. The highest figure for any 3-hour composite sample was 380 p.p.b. Removal of phenols in passing through the sewage plant varied from 5 to 33 percent.

Figure 12 shows the coliform results at range Dt-20.6, located approximately 1.2 miles above the sewage treatment plant outlet. The data, from the city of Detroit records, indicate the quality of the river water at this range before and after the advent of sewage collection and treatment. The coliform concentration in the Detroit River, within 300 to 600 feet of the United States shore, was approximately 10 times greater before sewage treatment than after. This re-

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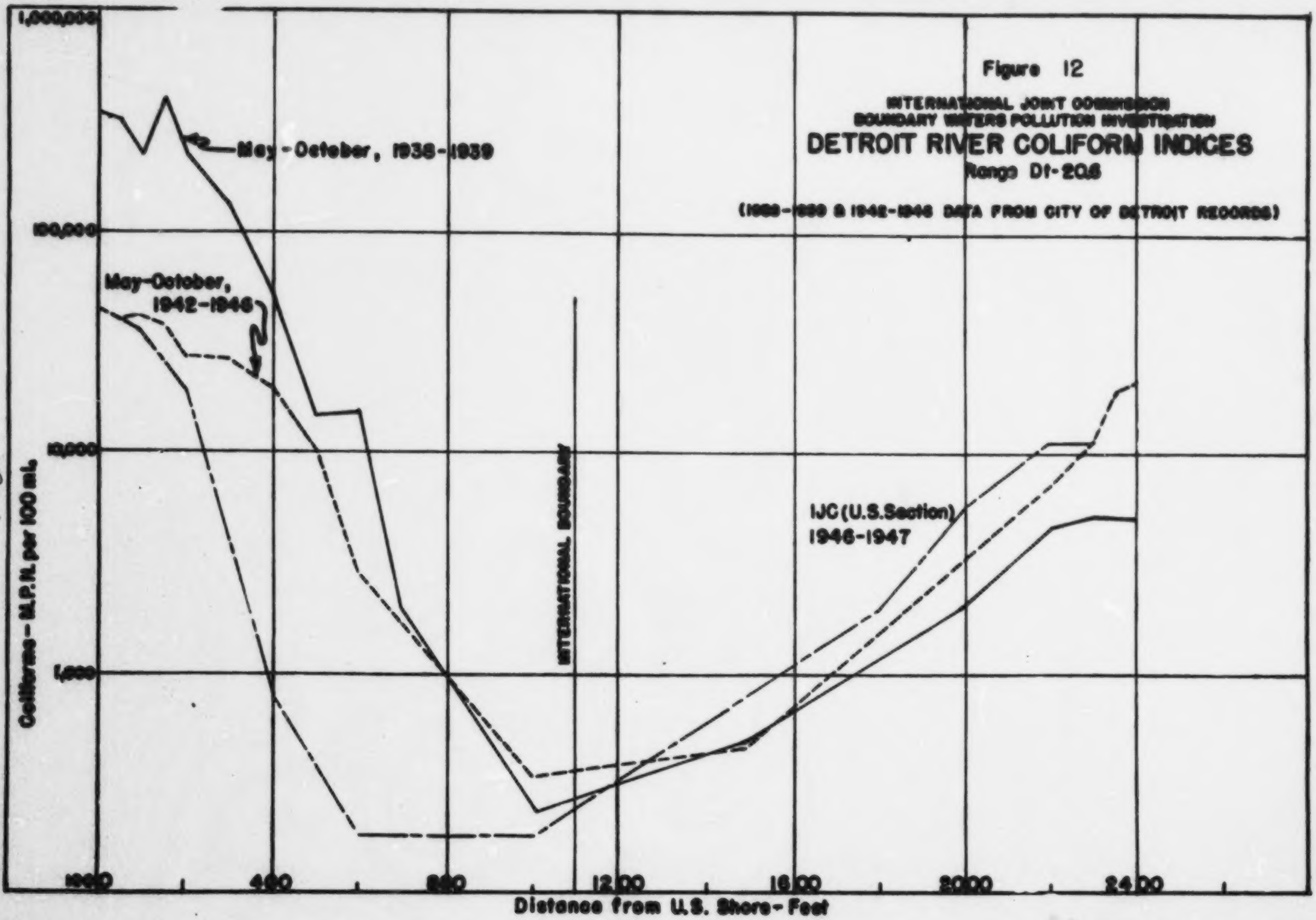


Figure 12

INTERNATIONAL JOINT COMMISSION
BOUNDARY WATERS POLLUTION INVESTIGATION
DETROIT RIVER COLIFORM INDICES
Range Dt-20.6

(1938-1939 & 1942-1946 DATA FROM CITY OF DETROIT RECORDS)

(Follows Page 180)

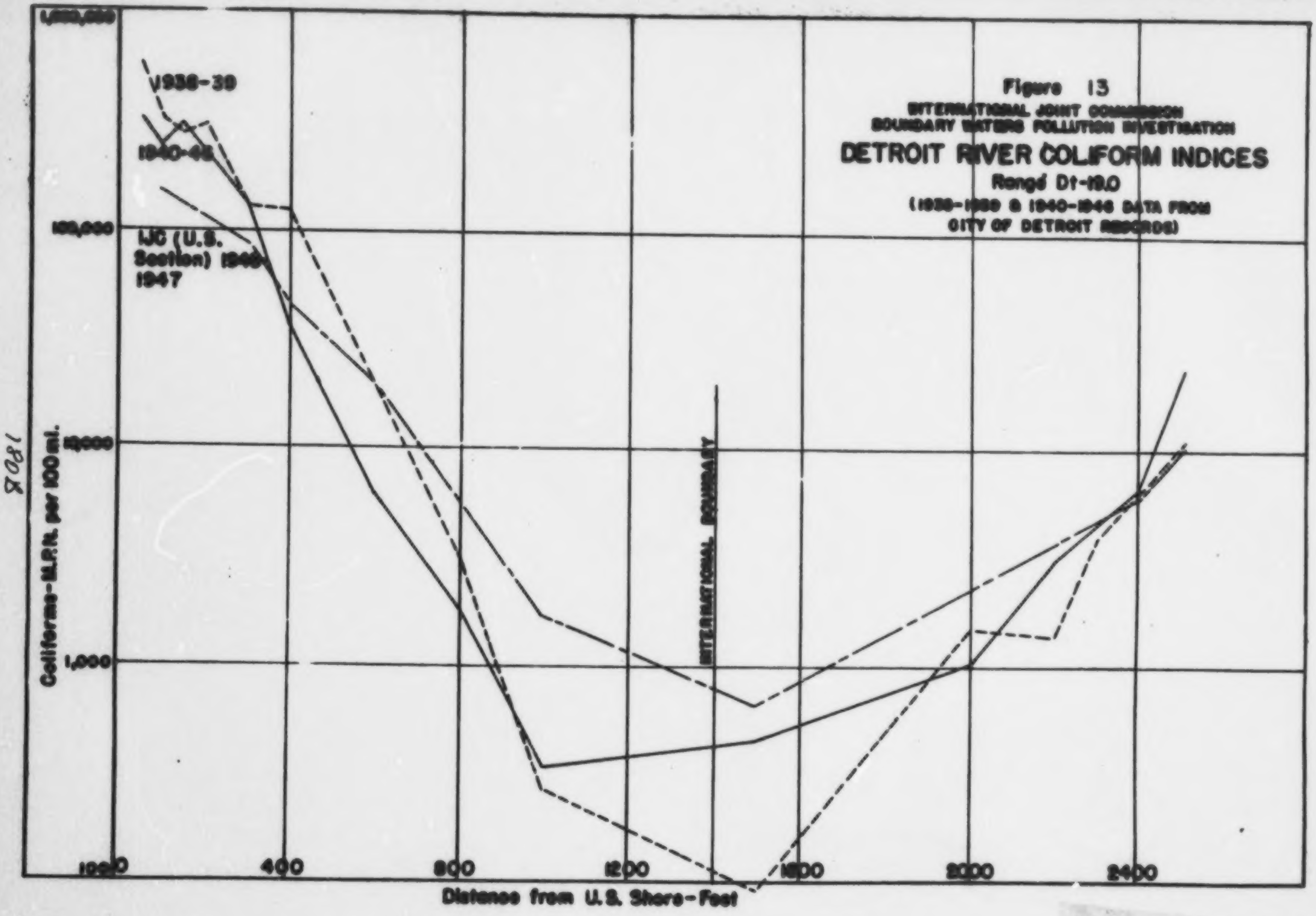


Figure 13

INTERNATIONAL JOINT COMMISSION
BOUNDARY WATERS POLLUTION INVESTIGATION

DETROIT RIVER COLIFORM INDICES

Range Dt-19.0

(1938-1939 & 1940-1946 DATA FROM CITY OF DETROIT RECORDS)

(Follows Page 192)

duction can be attributed to the interception of numerous raw sewage outfalls by the main trunk sewer leading to the sewage treatment plant. There was little or no change in the quality of the water at mid-stream.

Figure 13 presents the coliform concentrations at range Dt-19.0 nearly one-half mile below the treatment plant outlet. The Detroit records show that, within 300 feet of the United States shore, the results at this range before treatment were about the same or somewhat higher than after treatment. From this point to a distance of 900 feet from shore, the coliform concentration after sewage treatment is significantly less than before. In contrast, coliform results found by the field staffs show lower coliform numbers, than before treatment, to a point 600 feet from the United States shore but higher values across the remainder of the river. All data, however, follow the same general trend in concentrations.

The improvement brought about by the Detroit sewage treatment plant is partly offset by the heavy bacterial load introduced from the Rouge River. Coliform results of sampling at several locations further below the treatment works outlet show a relative improvement in the quality of the Detroit River water since the operation of the plant. Chlorination of the plant effluent began on July 3, 1940. At the Trenton Channel toll bridge (range Dt-12.0w) the coliform index for 1939, prior to sewage treatment, was 62,270, and in 1941, after treatment, the index was 20,240 per 100 ml. The field staffs' data show an average index of 15,500 for this range in 1946-1948. At range Dt-9.3e the coliform index for 1938-1939 averaged 20,000 from the Grosse Ile shore to the International Boundary. In 1940-1946 it averaged 7,500, and in 1946-1948 the average for the samples taken by the field staffs was 4,000.

CHAPTER IX

TRANSBOUNDARY MOVEMENT OF POLLUTION

In the treaty of 1909 between the two countries it was agreed that "the boundary waters and waters flowing across the boundary shall not be polluted on either side to the injury of health or property on the other." In the reference for this investigation an answer was sought to the questions of whether transboundary movement of pollution was taking place, to what extent, and in what localities. The information utilized in answering these questions was obtained from float studies, special investigations, and a review of data from various sources.

FLOAT MOVEMENTS

It is apparent from information presented in chapter IV that transboundary currents occur at various places in this section. In the St. Clair River, surface float studies indicated a crossing of surface waters from the Canadian side to the United States side in the area between St. Clair and Marine City. Similar floats released on the United States side were generally carried downstream and crossed to the Canadian side between Courtright and Sombra. Reports were received on 380 out of a total of 1,020 surface floats released in the St. Clair River. Of these, 32 crossed from the United States to Canada, and 97 crossed from Canada to the United States. On the other hand, a three weeks' study of sub-surface floats submerged to depths of 2 to 20 feet and released along both shores, in the Sarnia-Port Huron area, revealed that they followed a course parallel to the shores and showed no pronounced tendency to cross the International Boundary. The deeper floats, at 15 to 20 feet, released on the Canadian side near Port Lambton, travelled down the Chenal Ecarte, while those submerged to depths of less than 10 feet followed down the main or South Channel and probably across the boundary.

In Lake St. Clair both surface and depth floats crossed the boundary at different points. Movements of water were not well defined but depended largely on wind direction and intensity. Surface floats released at the outlet of Anchor Bay crossed the boundary to Mitchell Bay, and the south shore of the lake. Depth floats also followed a similar course toward the boundary. It is probable that these would cross the boundary under certain wind conditions. There was no indication of currents from the east side of Lake St. Clair crossing the boundary prior to the approach to the Detroit River.

In the Detroit River, surface floats crossed from side to side throughout the length of the stream. In the upper part these floats crossed from the United States side through the opening between Peach Island and Belle Isle to the Canadian side. Several surface floats released at the mouth of the Rouge River and in the vicinity of the Detroit sewage treatment plant outlet were found on the Canadian shore opposite the upper end of Fighting Island. Only those depth floats placed 1,000 feet or more off the United States shore, opposite Windmill Point, crossed the boundary. A limited number of depth floats placed in United States waters near the boundary at the head of Fighting Island crossed into Canadian waters at the foot of this island.

BELLE ISLE - PEACH ISLAND STUDIES

Hydrometric data show a division of flow which transfers 40 percent of the total river volume from the United States side through the opening between Belle Isle and Peach Island to the Canadian side of Belle Isle. The boundary cross-over at this location prompted a special study in the spring of 1948 to determine the existence of any transfer of pollution with this flow.

A system of ranges and sampling points was established across the several channels between the United States and Canadian shores in that section of the Detroit River between Peach Island and Belle Isle. The locations of these ranges and sampling points are indicated in figures 14 and 15. These also show the distribution of average analytical results.

Numerous samples of the river water were collected for examination of the more significant indices of pollution including coliforms, turbidity, chlorides and ammonia. A summary of the analytical results, showing the coliform figures, is presented in table 26.

The coliform indices for the various ranges used in this study tend to confirm the observations on float behavior. Accordingly, under normal conditions, a transfer may be expected to occur only when the pollution from the United States side were extended beyond 1,000 feet from shore in the vicinity of Windmill Point. Abnormal conditions of storm discharge and wind action may extend this zone of shore pollution beyond the usual limit in the river. There is indication of this in the maximum M.P.N. values at ranges Dt-30.0 and Dt-30.8w. While the median figures steadily decrease from shore toward midstream the maximum figures indicate an extended zone of pollution at certain times.

Turbidity results shown in figure 15, on these two ranges, indicate a distribution comparable to that of the coliforms.

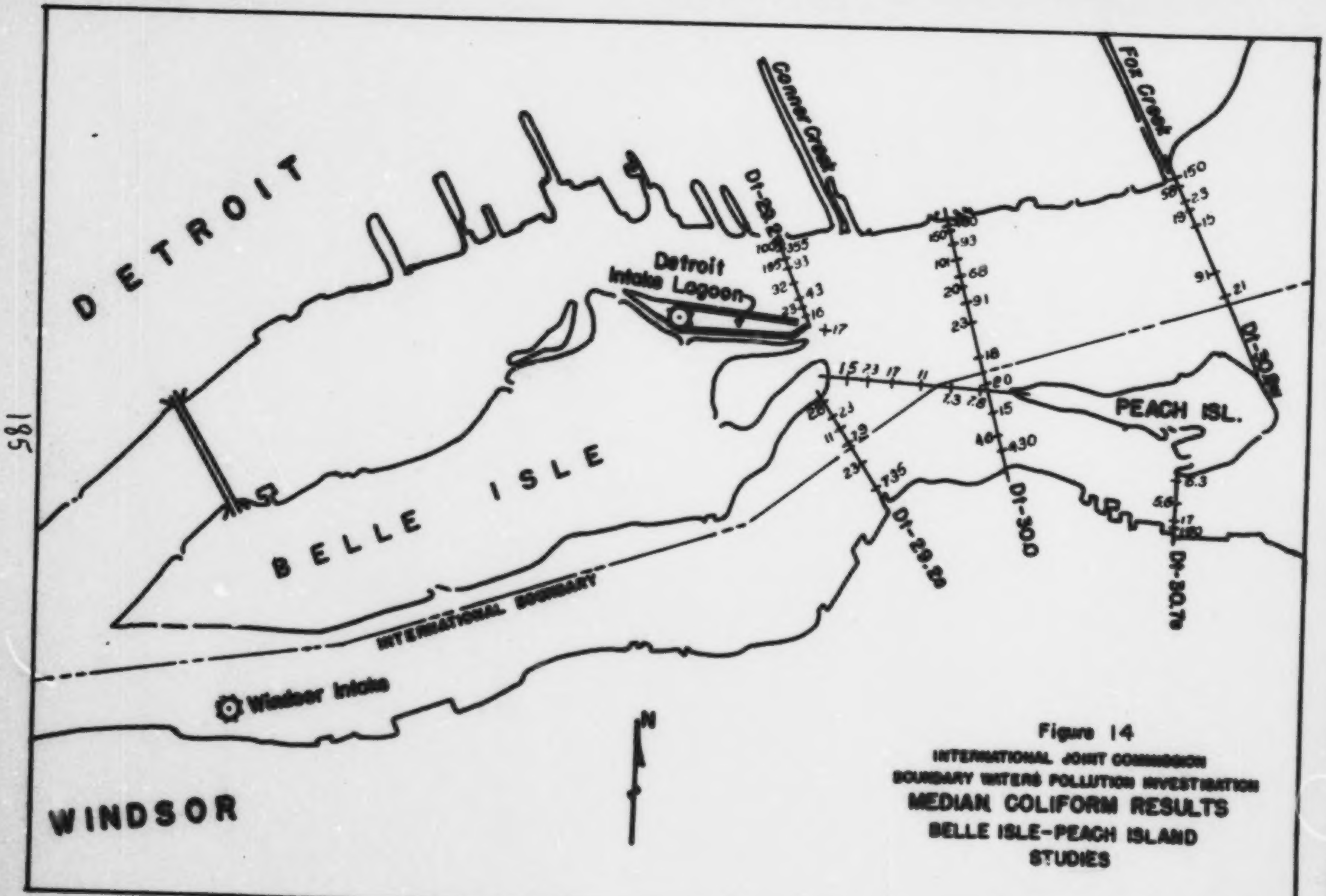
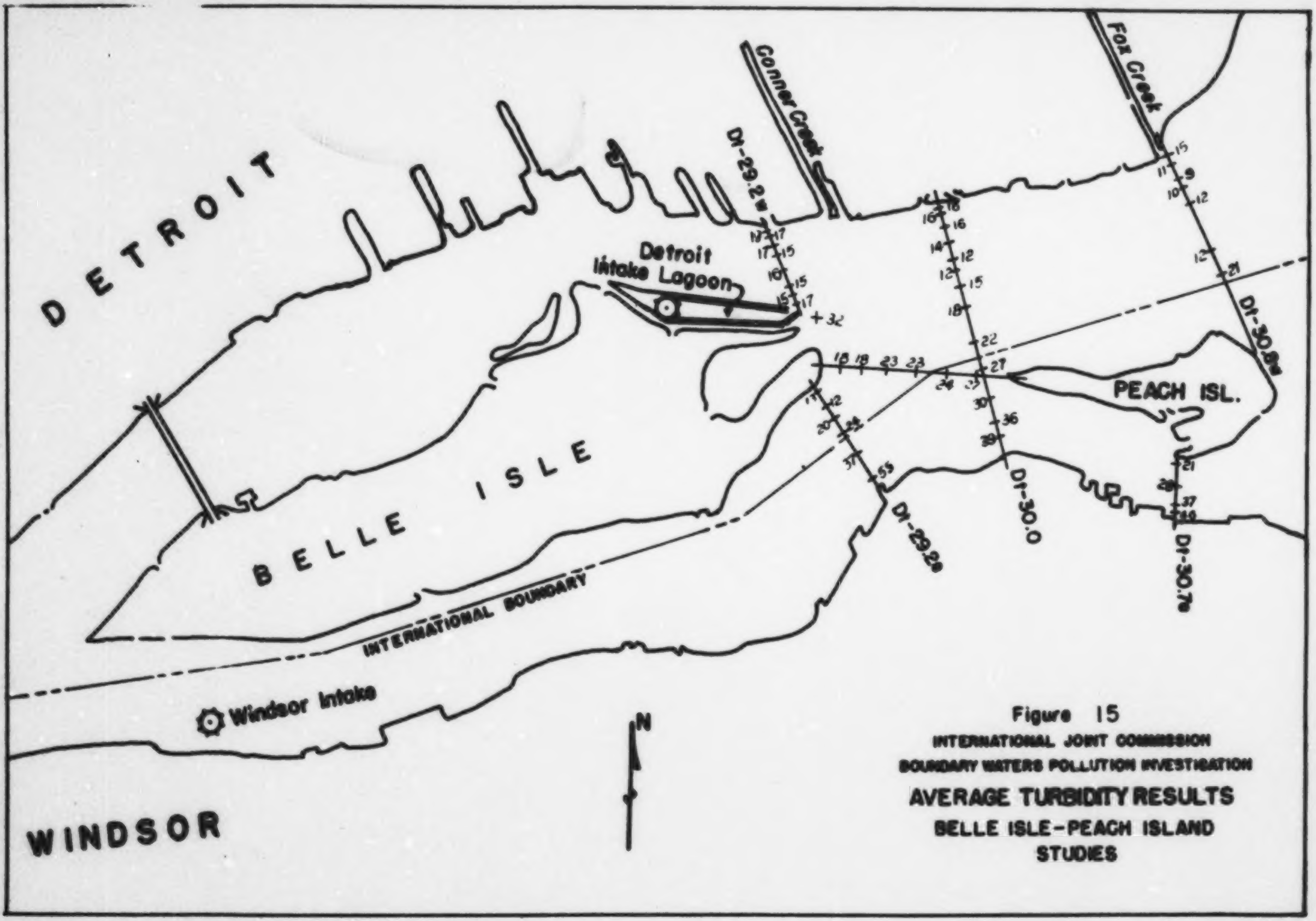

DETROIT
BELLE ISLE
WINDSOR
Conner Creek
Fox Creek
Detroit Intake Lagoon
PEACH ISL.
INTERNATIONAL BOUNDARY
Windsor Intake
N
DI-29.88
DI-30.0
DI-30.78
1005
355
195
93
32
43
23
16
17
15
23
17
11
7.3
7.8
20
28
23
11
7.9
23
735
150
93
101
68
20
91
23
18
15
40
430
150
58
2.3
19
15
91
21
8.3
5.6
17
180

Figure 14
INTERNATIONAL JOINT COMMISSION
BOUNDARY WATERS POLLUTION INVESTIGATION
MEDIAN COLIFORM RESULTS
BELLE ISLE-PEACH ISLAND
STUDIES

(Follows Page 184)


DETROIT
BELLE ISLE
WINDSOR
Detroit Intake Lagoon
Windsor Intake
INTERNATIONAL BOUNDARY
Conner Creek
Fox Creek
PEACH ISL.
N
Dt-29.2w
Dt-29.2e
Dt-30.0
Dt-30.7e
Dt-30.8w
17 17
17 15
16 15
15 17
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18 18 23 23
24 27
17 12
20 24
37 53
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16 16
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Figure 15
INTERNATIONAL JOINT COMMISSION
BOUNDARY WATERS POLLUTION INVESTIGATION
AVERAGE TURBIDITY RESULTS
BELLE ISLE-PEACH ISLAND
STUDIES

(Follows Page 184)

Table 26 - COLIFORM RESULTS - BELLE ISLE-PEACH ISLAND STUDIES

Mileage Index Number	Distance from Shore (Feet)	Number of Samples	Coliforms - M.P.N. per 100 ml.		
			Median	Maximum	Minimum
Dt-30.8w	20	9	150	24,000	1.8
	200	9	58	1,100	1.8
	500	9	23	2,400	1.8
	700	9	19	1,100	1.8
	1000	9	15	3,500	1.8
	2000	9	9.1	1,700	1.8
	2500	9	21	43	1.8
	2600	INTERNATIONAL BOUNDARY			
Dt-30.7e	100	9	6.3	43	1.8
	500	9	5.6	23	3.0
	850	9	17	460	1.8
	980	9	150	5,400	17
Dt-30.0	100	13	460	17,000	13
	200	13	150	4,600	2.0
	400	13	93	2,600	4.0
	700	13	101	350	1.8
	1100	13	68	240	1.8
	1300	13	20	920	1.8
	1600	13	9.1	1,600	4.5
	2000	13	23	93	3.6
	2700	13	18	350	1.8
	3300	13	8.0	2,400	2.0
	3900	13	15	93	1.8
	4300	13	46	1,500	1.8
	4600	13	430	3,100	46
Dt-29.7	3000	14	7.8	220	1.8
Dt-29.6	3000	14	7.3	23	1.8
Dt-29.5	3000	13	11	43	1.8
Dt-29.4	3000	14	17	79	2.0
Dt-29.34	3000	14	23	460	1.8
Dt-29.26	3000	15	15	540	1.8
	1700	7	17	240	2.0

Table 26 - COLIFORM RESULTS - BELLE ISLE-PEACH ISLAND STUDIES (continued)

Mileage Index Number	Distance from Shore (feet)	Number of Samples	Coliforms - M.P.N. per 100 ml.		
			Median	Maximum	Minimum
Dt-29.2e	100	12	28	430	1.8
	400	12	23	220	2.0
	700	12	11	43	1.8
	1000	11	7.9	93	1.8
	1500	12	23	540	3.6
	2000	12	735	35,000	33
Dt-29.2w	100	12	700	160,000	11
	250	12	355	8,400	4.5
	400	12	195	2,400	4.5
	600	12	93	5,400	1.8
	900	12	92	540	1.8
	1300	12	43	240	4.0
	1500	12	23	930	1.8
	1700	12	16	430	2.0

SUPPLEMENTARY INFORMATION

Certain information in addition to that already discussed has been utilized in determining the transboundary movement of pollution.

Indications of coliform pollution crossing the boundary are seen at a number of places. In the St. Clair River there is a diffusion of coliforms at range SR-17.5, between Sombra and Marine City, after passage through a narrow section of the river. This indicates a transboundary movement of pollution. In Lake St. Clair the coliform concentrations indicate a flow of pollution from Anchor Bay across the boundary similar to the path followed by the floats. Diffusion of coliform concentrations occur at several places in the lower Detroit River, beginning on the Canadian side at the head of Fighting Island. This may be influenced by material from across the boundary. More uniform distribution is found at range Dt-12.0w in Trenton Channel and at range Dt-9.3e, which crosses the boundary above Amherstburg. These ranges are on either side of Grosse Ile. On range Dt-3.9, at the mouth of the Detroit River, there is a trend to uniform distribution across the entire width of the river.

Transboundary movement of pollution was demonstrated by an accidental spill of phenol in the Sarnia area. This took place on November 30 and December 1, 1948. Severe taste occurrences were reported at Wallaceburg on December 1, and at the Detroit water treatment plant on December 7 to 10. This was followed by tastes at Windsor on December 14 and 21. At neither Detroit nor Windsor did these tastes reach the consumers.

Similarly on February 15, 1946, Wallaceburg had a severe phenolic taste in the municipal water supply. On February 20 distinct taste occurrences were common to both Detroit and Windsor, further indicating a probable transboundary movement.

Oils and greases were observed on both sides of the boundary at various places. In view of the paths of surface floats it is obvious that these substances do cross the boundary.

Reference has been made to reversals of flow in the Detroit River and Lake St.Clair. As a result of the mixing which occurs in the lower Detroit River it is probable that there will be a transboundary flow of pollution under these conditions.

In addition to transboundary carriage of pollution by natural agencies transfer is brought about by artificial means such as navigation, dredging, and industries. Vessels take on and discharge ballast water at both sides of the boundary. Dredging operations may carry pollution across the boundary as the result of depositing masses of heavy pollution near the boundary line. One industry in the United States pipes its wastes to waste beds on Fighting Island, and these beds overflow into Canadian waters.

The several data presented herewith clearly demonstrate the transfer of pollution from either side of the boundary to the other at a number of locations.

CHAPTER X

DISCUSSION OF FINDINGS AND REMEDIAL MEASURES

Data presented in this report show the results of the investigation of pollution in the Lake Huron - Lake Erie section of the boundary waters. They indicate, in accordance with the terms of reference to the Commission, the extent, nature and sources of pollution, and in what localities such pollution occurs. The Board has examined and evaluated these various data. From this analysis certain conclusions have been reached and remedial measures have been determined. The findings and conclusions are discussed herewith.

Canada and the United States jointly possess an unparalleled natural resource in these boundary waters. They constitute the largest body of fresh water in the world and are subject to a multiplicity of uses. Because they vitally affect the health, economy and recreation of both countries it is essential that the waters be so safeguarded from pollution that their use will be in the highest public interests. The importance attached to the requirement of maintaining these waters in an unpolluted state is evident in the action taken by the two governments, on two separate occasions, in requesting that the International Joint Commission make an investigation of pollution.

THE 1913 INVESTIGATION

The pollution problem in 1913 was materially different from that of today. The earlier investigation was concerned solely with bacterial pollution from domestic sewage. The industrial processes, then in use, did not discharge waste products in sufficient quantities to affect seriously the condition of the waters. It was pointed out, however, that the industrial wastes might soon create a problem and require regulation.

It has been stated in chapter VIII that certain areas of the boundary waters were seriously polluted in 1913, with the worst conditions being found in the Detroit River and St. Clair River, below major centers of population. There were no municipal sewage treatment plants then in operation, and the sewage was discharged through many outlets along the waterfront. All municipalities obtained their drinking water supplies from the adjacent waters above their own sewer outfalls. The only safeguard against contamination was chlorination of the water. Filtration was not in use on any municipal supply.

The International Joint Commission, following the 1913 investigation, recommended to the two governments that, for the boundary waters as a whole,

> "It is feasible and practicable, without imposing an unreasonable burden upon the offending communities, to prevent or remedy pollution, both in the case of boundary waters and waters crossing the boundary.
>
> "(a) In the case of city sewage, this can best be accomplished by the installation of suitable collecting and treatment works, the latter having special reference to the removal of bacteria and matters in suspension.
>
> "(b) In the case of vessel sewage, a feasible and inexpensive remedy lies in the employment of recognized methods of disinfection before it is discharged. In the case of water ballast suitable rules and regulations should be prescribed with a view of protecting the water intakes.
>
> "(c) The discharge of garbage and sawmill waste into boundary waters should be prohibited, and industrial and other wastes, which are causing appreciable injury, should be discharged subject to such restrictions as may be prescribed."

CHANGES IN PERIOD 1913-1946

Many changes have taken place in the period from 1913 to 1946 which have affected the pollution problem. Two factors which have contributed adversely to this problem are the increases in population and industrial activities. Comparative populations in the Lake Huron - Lake Erie section in 1913 and 1948 are shown in table 27. The population has risen from 772,100 to 2,589,600. It should be noted that these figures cover only those municipalities situated on the boundary waters. The populations residing on the waters tributary to the boundary streams and lakes are not included.

Table 27 - POPULATIONS SITUATED ON BOUNDARY WATERS, 1913 AND 1948

Area	1913			1948		
	Canada	United States	Total	Canada	United States	Total
St. Clair River	9,900	29,100	39,000	31,400	52,000	83,400
Lake St. Clair	15,800	12,300	28,100	30,900	74,900	105,800
Detroit River	26,000	679,000	705,000	142,300	2,258,100	2,400,400
Total	51,700	720,400	772,100	204,600	2,385,000	2,589,600

Although the matter of industrial wastes was of little or no concern in 1913 it is today a major problem. Vast expansion in industrial activities has resulted in great volumes and varieties of wastes.

The pollution problem in the interval from 1913 to 1946 has forced municipalities to construct sanitary works for water supply protection. Virtually all municipalities, with the exception of Port Huron and Sarnia, both above the sources of pollution, have installed water filtration plants. Installations for the treatment of domestic wastes have not kept pace with the extension of sewer services and the treatment of water supplies, but definite progress has been made. The city of Detroit has installed interceptors and sewage treatment works to provide primary treatment for the city and over 20 surrounding communities. Other treatment plants were built at Dearborn, Wyandotte, and Trenton in Michigan, and at Riverside in Ontario. These plants now give primary treatment for 2,250,000 persons on the United States side and secondary treatment for 5,000 persons on the Canadian side. Much of the cost of this work on the

United States side was financed with Federal Government aid during the period of 1933 to 1940.

In this same period, sanitary science has made important contributions toward solving pollution problems. Research in analytical procedures and treatment methods has made it possible to define more clearly, both qualitatively and quantitatively, the nature, extent, and effects of pollution and to apply corrective measures.

The science of water purification in 1913 was in the initial stages of development. While filtration had been developed it had not been employed anywhere along these boundary waters. Chlorine was added to the water in the form of hypochlorite, but the method of application was crude and often ineffective. Present day methods in chlorine application and control for disinfection were unknown. Most cities and towns with the highest typhoid fever rates used water without the safeguard of either effective filtration or chlorination.

Corresponding advances have been made in the art of sewage and industrial waste treatment. New and improved processes have resulted in greatly increased efficiencies and in the removal, to a high degree, of objectionable polluting substances.

EXTENT AND EFFECTS OF POLLUTION IN 1946-1948

The 1946-1948 investigation revealed pollution in numerous localities, originating from many sources. The analytical data, derived from bacteriological, chemical, and physical examinations, are a measure of the extent and effects of various pollutants on waters used for the purposes already enumerated. The kinds, degree, and locations of pollution are set forth in detail in chapters VII and VIII. The findings are reviewed herewith in the light of their effects on these waters and in relation to the questions contained in the terms of reference.

Transboundary Movement

In the treaty of 1909 between the two countries it was agreed that the waters on either side of the boundary should not be polluted to the injury of health or property on the other side. The first question asked in the present reference to the Commission involves this transboundary aspect of the pollution problem.

The data presented in chapter IX have shown clearly that there is a transboundary crossing, both of currents and pollution, from each side to the other. Since waste discharges tend to diffuse and become diluted with the receiving waters, it is difficult to trace a specific effluent over the distance required to dissipate its potency. Added dilution through travel downstream and the admixture of similar or other deleterious materials further complicate this difficulty. The intermingling is also influenced by winds, bends in the river, islands or other obstructions, and navigation channels. These effects may not be constant. Under these circumstances it is not feasible to state, in exact terms, the amount of pollution which crosses from each country to the other.

Injury to Health

The danger to health in the use of these waters is measured most readily by the coliform determinations, although constituents of a chemical nature are also of sufficient importance to warrant consideration. Major purposes for which these waters are used include domestic water supply, bathing, and recreation. All of these uses are closely allied to public health and are injuriously affected by the discharge of bacterial and chemical wastes.

Limits of pollution beyond which a health menace may exist are not universally accepted. Several standards have been formulated from time to time to apply to specific areas and requirements. In the final report on the 1913 investigation the Commission stated that "the standard of purification required of these communities should be such that the streams after receiving their treated sewage would have a mean annual cross-sectional average of B. coli not exceeding 500 per 100 c.c." A more recent standard for raw waters, acceptable for treatment and use as public water supplies, is that recommended by the U. S. Public Health Service in 1946. In this recommendation, waters which have an average monthly coliform content of not more than 50 per 100 ml. are acceptable for treatment by simple chlorination alone. Raw waters having an average monthly coliform content of not more than 5,000 per 100 ml. and exceeding this number in not more than 20 percent of the samples examined in any one month are acceptable for treatment by complete rapid sand filtration and continuous postchlorination. In cases where the coliform bacteria exceed 5,000 per 100 ml. in more than 20 percent of the samples examined during any one month and do not exceed 20,000 per 100 ml. in more than 5 percent of the samples examined during any one month the waters shall be acceptable when given auxiliary treatment in addition to complete rapid sand filtration and continuous postchlorination. Waters containing coliform bacteria in excess of the above figures are considered unsuitable for use as a source of drinking water supply unless brought into conformance by means of prolonged preliminary storage or some other satisfactory measure.

Since practically all of the municipalities on the Lake Huron - Lake Erie section obtain their supplies from the boundary waters, pollution by human sewage may be said to affect the entire population. While there have been no typhoid fever outbreaks attributable to public water supplies in either Michigan or Ontario in recent years, the effects of water pollution have been manifested in other ways. Advances in water purification in the last 30 years have done much to reduce the menace of water-borne typhoid fever, but sewage contaminated waters can result in outbreaks of gastro-enteritis, particularly the diarrheas and dysenteries. Evidence of this is found in the occurrence at Detroit in 1926, when 45,000 persons were affected. The incident was reported to have been traced to the municipal water supply even though it was filtered and chlorinated. Other similar occurrences have been reported.

All sewage pollution must be considered as a potential health hazard. Pollution also adds an extra burden in the form of higher costs for water purification, necessitated by the failure of some upstream user to treat adequately the wastes produced. Similarly, many riparian owners who may wish to use these waters are not in position to secure the protection provided by modern and properly controlled purification processes that can be installed by municipal bodies. Some municipalities are deprived of the right of developing public water supplies within economical limits. One example of this is seen in the necessity for abandoning the water supply at Trenton, Michigan, and for extending the intake at Wyandotte, Michigan, at a cost of $185,000.

It was shown in chapter VIII that the coliform pollution in the St.Clair River rises sharply below the cities of Port Huron and Sarnia and is sustained throughout the length of the river. The pollution is generally greatest near the shores. In a number of places the coliform figures are in excess of those considered safe for a raw water to be treated even by modern purification methods. The maximum counts reach excessive values, and thereby would impose a severe load on water purification processes. While it is still possible to locate intakes in zones where the bacterial pollution is within the limits recommended by the U. S. Public Health Service as acceptable, the water requires careful and sustained treatment to render it safe for drinking purposes.

In Lake St. Clair, the coliform values vary widely. Normally, in the central portion of the lake these figures are within the limits recommended for a public water supply protected by simple chlorination. In the vicinity of sewage outfalls and at the mouths of tributary streams the coliform index reaches high values and is in excess of the figure for safe water even when protected with modern purification processes. The worst condition is found on the United States side of the boundary. Natural purification agencies play an important role in reducing the pollution load discharged into the lake to a concentration where, in general, the water can be safely treated for domestic use.

The Detroit River contains the highest concentrations of coliform organisms found in the Lake Huron - Lake Erie section. The water treatment plants of Detroit and Windsor enjoy the benefit of natural purification effected in Lake St. Clair. Proceeding downstream the coliform pollution progressively increases. In the lower river, which is the source of water supplies for Wyandotte and Amherstburg, the coliform index far exceeds the limits for waters acceptable for treatment under the U. S. Public Health Service recommendations. These values are discussed in chapter VIII. In this area are found the difficulties and dangers associated with a highly polluted water as a public supply.

Tastes and odors in water supplies are caused principally by industrial wastes, and particularly phenolic compounds. One-tenth of one part per million of phenol alone will impart to water the characteristic taste and odor of carbolic acid. In water supplies which are chlorinated to protect against bacterial pollution, phenols react with chlorine to produce intensely aromatic compounds. These compounds, even when highly diluted, give to the water tastes and odors which are variously described as medicinal, chemical or iodoform. Two one-thousandths of one part of phenol in one million parts of chlorinated water (2 p.p.b.) may be sufficient to cause objectionable tastes and odors. This condition often compels the public to resort to other water supplies, which may be palatable but dangerously contaminated. The figures given in chapter VIII show phenolic concentrations in many places sufficiently high to cause objectionable tastes and odors. This taste situation is greatly aggravated by the wide variation in the phenol content of the industrial wastes, as well as by winds, currents, and other hydrometric conditions.

The ammonium ion of ammonium compounds in water supplies tends to combine with chlorine to form chloramines. Varying amounts of this substance present in water cause fluctuations in the chlorine demand. Erratic chlorine demand is a public health hazard, because it interferes with the disinfection of water supplies.

The presence of sewage pollution in the bathing areas located in these waters also constitutes a health hazard. The coliform data in chapter VIII show that the shore waters are heavily contaminated in a large part of the Lake Huron - Lake Erie section, and in excess of an M.P.N. value of 2,400 per 100 ml. This has resulted in inconvenience and extra cost to the local population for travelling to more distant points. There are few areas in this section of the boundary waters available for public bathing, and it has been necessary to close most of these at times for health reasons.

The city of Detroit has, by ordinance, prohibited bathing along its entire water front. There is the further problem of those who do not have access to safe bathing facilities and who disregard the danger from swimming in heavily polluted areas.

Injury to Property

Property has been injured through the discharge of sewage and industrial wastes into these waters. Bacterial pollution has added to the cost of water treatment. It has also meant an economic loss for owners of bathing beaches and for the owners of properties which could be developed for this purpose. The discharge of industrial wastes has interfered with the use of these waters and has resulted in property damage. Wastes containing oils, greases or tars have fouled bathing beaches, coated swimmers, and caused destruction of wildfowl. Any concentration of oil coats the hulls of boats and docks and creates a fire hazard.

Phenols from industrial wastes interfere with the enjoyment of property rights by increasing the cost of water treatment or by excluding the use of the water for industrial or domestic purposes. Phenol in water kills fish by producing paralysis of the neuromuscular mechanism and hemolizing the blood. Fish tend to swim toward higher concentrations of phenol. Cases have been reported where the concentrations of phenol were not large enough to destroy the fish, but the flesh was tainted with phenol and was inedible.

Ammonium compounds increase the cost of water treatment and are toxic to fish. Cyanides, strong acids, and oxygen-depleting wastes have caused the destruction of fish and wild life. Aesthetic values have been injured by promiscuous discharge of such materials as refuse, oils, greases, and tars. All of these conditions are found in these watercourses.

SOURCES OF POLLUTION

Pollution of these waters is due principally to the discharge of domestic sewage and industrial wastes. Many industries dispose of their wastes into public sewers, others have separate outlets directly to the boundary waters or their tributaries. While wastes are discharged throughout the entire section of these waters, there are several zones in which the volume of pollution is concentrated.

Sources of Domestic Wastes

Table 12, in chapter VII, lists the principal sources of domestic wastes. The outfalls for these wastes are grouped at the centers of large populations.

On the United States side of the St. Clair River the major portion of the domestic wastes is contributed by Port Huron and the surrounding areas. The sewered population of over 31,000 at Port Huron alone constitutes 75 percent of the total sewered population on this side of the river. Raw sewage from municipalities downstream from Port Huron tends to sustain the pollution load in the river and offset the effects of dilution and natural purification. On the Canadian side the entire sewered population of 23,000 is in the Sarnia area. At present, no community downstream from this area has public sewers, but it may be anticipated that sewers will be provided later.

In Lake St. Clair the major discharge of domestic wastes, on the United States side, occurs along the west shore, chiefly from the Clinton River. There are intermittent discharges at points south of the Clinton River caused by combined sewer overflows. The dry weather sewage flow from the communities responsible for these overflows is normally pumped to the Detroit sewer system. For periods of five months or more each year the entire flow of sewage from the South Macomb Sanitary District is discharged untreated directly to the lake. The sewered population on the Canadian side is confined chiefly to tributary streams. The outfalls are not concentrated at any point on the boundary waters.

In the Detroit River, on the United States side, the discharge of domestic wastes is concentrated in the lower reaches extending from the Rouge River to Lake Erie. The principal sources of pollution are the Rouge River, Detroit sewage plant effluent, and sewage from the communities along the Trenton Channel. The lower Rouge River receives domestic sewage from a population of 326,000, nearly all of which is given partial treatment. The Detroit plant, providing primary treatment of the sewage, serves a sewered population of 2,200,000. Not all of the city's sewage reaches the plant. Some raw sewage enters the river at a number of outlets along the waterfront. The Trenton Channel outfalls, from plants giving primary treatment, serve a sewered population in excess of 100,000. On the Canadian side, in the Windsor area, raw sewage is discharged through multiple outlets from a population of nearly 120,000. Downstream, the Amherstburg area adds raw sewage from a sewered population of about 2,000.

In the Lake Huron - Lake Erie section, the present survey showed a daily discharge of 514 million U.S. (428 million Imp.) gallons of municipal wastes. Of this amount, about 400 million U.S. (333 million Imp.) gallons receive some degree of treatment. This proportion of treatment does not apply at all times since these communities have provision for spilling combined storm and sanitary flows directly into the streams during periods of high runoff.

Sources of Industrial Wastes

A summary of industrial waste discharges, showing distribution by areas, is given in table 16 of chapter VII. These wastes are discharged throughout the Lake Huron - Lake Erie section, but heavy concentrations occur in certain zones. A total of 1,430 million U.S. (1,191 million Imp.) gallons is discharged daily. This volume includes condenser and cooling water as well as process wastes. These effluents contain large quantities of pollutants which have an adverse effect on the receiving waters. The daily discharge of the more significant of these wastes was found to be: 6,340 pounds of phenols, 3,700 pounds of cyanides, 11,600 pounds of ammonium compounds, 18,730 U.S. (15,590 Imp.) gallons of oils, 2,296,000 pounds of suspended solids, and organic matter having a biochemical oxygen demand of 421,200 pounds. These last two quantities do not include the entire population load from the seasonal operation of certain food processing industries. Most of such industries are on tributary streams.

Sources of Other Wastes

In addition to municipal and industrial effluents, these waters receive wastes from navigation, dredging, and careless dumping of refuse at shore points.

In 1947, at the height of the navigation season, the domestic sewage discharge from vessels was equivalent to that from a daily population of 3,900 and amounted to an estimated 120,000 U.S. (100,000 Imp.) gallons per day. For this same period, the estimated amount of garbage averaged 2,000 pounds per day. Bilge water contained an estimated quantity of 40 (U.S.) gallons of oil per day. No estimate was possible for the amount of ballast water, or the amount of polluting substances transferred from place to place in this water.

The character of the wastes resulting from dredging operations is dependent upon the source of the dredged material. Substantial amounts of polluting substances can be transferred in this way. Reference has been made in chapter VII to the amount of pollutants removed from the Rouge River and dumped into the Detroit River.

There is no widespread dumping of garbage or other refuse into these waters, but some does occur from small water craft, shore residences, and by careless persons. This practice causes unsightly appearances in some local areas.

REMEDIAL MEASURES

It has been shown that serious pollution exists in the Lake Huron - Lake Erie section of the boundary waters. Its nature, extent, and sources have been presented in detail. This pollution has an injurious effect on the uses of these waters for domestic and industrial water supplies, bathing, recreation, and fish and wild life. It crosses from each side of the boundary to the other. A further question in the terms of reference concerns the measures necessary for remedying the situation. If such measures are to be effective, they must raise the quality of the waters to the point where they can be used satisfactorily for these various purposes.

Objectives for Boundary Waters Quality Control

Remedial measures involve the treatment or control of all sources of pollution reaching the boundary waters and their tributaries. Information acquired during the investigation enabled the Advisory Board to prepare "Objectives for Boundary Waters Quality Control."

The formulation of water quality objectives is essential for defining the remedial measures necessary for correcting pollution. Objectives may be established in two ways: (1) through limitation of the quantity of deleterious substances allowed to enter the receiving streams, or (2) through limitation of these substances within the receiving waters. Whichever type of objective is used, the end result must be the same, namely, maintenance of the water in a condition suitable for all subsequent uses.

Objectives adopted for boundary waters quality control establish the ultimate aim of corrective measures. Objectives must be defined if stream sanitation is to be accomplished, and they must be impartial in setting goals for all uses. Each purpose will require a specific quality of water. In the majority of cases, the uses of any one watercourse are varied, and complex interrelationships must be considered in objectives consistent with all uses. These principles have been adhered to in the formulation of the following objectives, and as revised October, 1950.

The term "boundary waters" as herein used shall include the waters defined in the references to the International Joint Commission dated April 1, 1946, and October 3, 1946, as follows:

St. Clair River, Lake St. Clair, the Detroit River, and
St. Marys River from Lake Superior to Lake Huron.

These objectives are for the boundary waters in general, and it is anticipated that in certain specific instances, influenced by local conditions, more stringent requirements may be found necessary.

GENERAL OBJECTIVES

All wastes, including sanitary sewage, storm water, and industrial effluents, shall be in such condition when discharged into any stream that they will not create conditions in the boundary waters which will adversely affect the use of these waters for the following purposes: source of domestic water supply or industrial water supply, navigation, fish and wild life, bathing, recreation, agriculture and other riparian activities.

In general, adverse conditions are caused by:

(A) Excessive bacterial, physical or chemical contamination.

(B) Unnatural deposits in the stream, interfering with navigation, fish and wild life, bathing, recreation, or destruction of aesthetic values.

(C) Toxic substances and materials imparting objectionable tastes and odors to waters used for domestic or industrial purposes.

(D) Floating materials, including oils, grease, garbage, sewage solids, or other refuse.

SPECIFIC OBJECTIVES

In more specific terms, adequate controls of pollution will necessitate the following objectives for:

(A) Sanitary Sewage, Storm Water, and Wastes from Water Craft

Sufficient treatment for adequate removal or reduction of solids, bacteria and chemical constituents which may interfere unreasonably with the use of these waters for the purposes afore-mentioned.

Adequate protection for these waters, except in certain specific instances influenced by local conditions, should be provided if the coliform M.P.N. median value does not exceed 2,400 per 100 ml. at any point in the waters following initial dilution.

(B) Industrial Wastes

(1) Chemical Wastes - Phenolic Type

Industrial waste effluents from phenolic hydrocarbon and other chemical plants will cause objectionable tastes or odors in drinking or industrial water supplies and may taint the flesh of fish.

Adequate protection should be provided for these waters if the concentration of phenol or phenolic equivalents does not exceed an average of 2 p.p.b. and a maximum of 5 p.p.b. at any point in these waters following initial dilution. This quality in the receiving waters will probably be attained if plant effluents are limited to 20 p.p.b. of phenol or phenolic equivalents.

Some of the industries producing phenolic wastes are: coke, synthetic resin, oil refining, petroleum cracking, tar, road oil, creosoting, wood distillation, and dye manufacturing plants.

(2) Chemical Wastes, Other Than Phenolic

Adequate protection should be provided if:

(a) The pH of these waters following initial dilution is not less than 6.7 nor more than 8.5. This quality in the receiving waters will probably be attained if plant effluents are adjusted to a pH value within the range of 5.5 and 10.6.

(b) The iron content of these waters following initial dilution does not exceed 0.3 p.p.m. This quality in the receiving waters will probably be attained if plant effluents are limited to 17 p.p.m. of iron in terms of Fe.

(c) The odor-producing substances in the effluent are reduced to a point that following initial dilution with these waters the mixture does not have a threshold odor number in excess of 8 due to such added material.

(d) Unnatural color and turbidity of the wastes are reduced to a point that these waters will not be offensive in appearance or otherwise unattractive for the afore-mentioned uses.

(e) Oil and floating solids are reduced to a point such that they will not create fire hazards, coat hulls of water craft, injure fish or wild life or their habitat, or will adversely affect public or private recreational development or other legitimate shore line developments or uses. Protection should be provided for these waters if plant effluents or storm water discharges from premises do not contain oils, as determined by extraction, in excess of 15 p.p.m., or a sufficient amount to create more than a faint irridescence.

Some of the industries producing chemical wastes other than phenolic are: oil wells and petroleum refineries, gasoline filling stations and bulk stations, styrene co-polymer, synthetic pharmaceutical, synthetic fibre, iron and steel, alkali chemical, rubber fabricating, dye manufacturing, and acid manufacturing plants.

(3) Highly Toxic Wastes

Adequate protection should be provided for these waters if substances highly toxic to human, fish, aquatic, or wild life are eliminated or reduced to safe limits.

Some of the industries producing highly toxic wastes are: metal plating and finishing plants discharging cyanides, chromium or other toxic wastes; chemical and pharmaceutical plants and coke ovens. Wastes containing toxic concentrations of free halogens are included in this category.

(4) Deoxygenating Wastes

Adequate protection of these waters should result if sufficient treatment is provided for the substantial removal of solids, bacteria, chemical constituents and other substances capable of reducing the dissolved oxygen content of these waters unreasonably. Some of the industries producing these wastes are: tanneries, glue and gelatin plants, alcohol, including breweries and distilleries, wool scouring, pulp and paper, food processing plants such as meat packing and dairy plants, corn products, beet sugar, fish processing and dehydration plants.

Note: The methods of determination of the chemical constituents referred to in the preceding objectives are as given in "Analytical Methods for Boundary Waters Quality Control," as prepared by the Board of Technical Advisers. Bacterial determinations are to include the presumptive and confirmed tests for the coliform group of bacteria as given in "Standard Methods for the Examination of Water and Sewage," 9th Edition.

Hearings Before the Commission

Public hearings for municipalities, industries, and all other interested parties were held by the Commission at Detroit and Windsor at the conclusion of the field studies. The purpose of these hearings was to obtain information on waste treatment processes now in use or proposed, cost estimates of remedial measures, time required to carry out these measures, and comments on the application of the objectives to specific wastes. The principal points developed at the hearings were as follows:

(a) The pollution of boundary waters between the United States and Canada reached such a degree of contamination in 1945 as to stimulate complaints coming from both sides of the boundary.

(b) The evidence brought out at the hearings indicates that the pollution affecting municipal water supplies is due both to industrial wastes and domestic sewage.

(c) Pollution in boundary waters has resulted in the serious destruction of wild fowl, fish and other aquatic life.

(d) Plans of industries for dealing with their waste problems indicate that most of the industries take their responsibilities for keeping deleterious wastes out of boundary waters seriously, and are making plans or have completed works for treatment of their wastes.

(e) Plans for collecting and treating municipal wastes as well as extending existing facilities are in preparation by various municipalities, including Detroit and the metropolitan area.

(f) Municipalities are relatively inactive at the present time as far as the construction of works for treating their wastes is concerned. Boundary waters are denied the benefits of municipal pollution control by the limited ability of communities to finance treatment works.

(g) The need for promptly providing funds to construct necessary municipal treatment works has been shown.

(h) The people living near the boundary waters have been frequently thwarted in their efforts to make recreational use of boundary waters because of pollution.

(i) The expenditure of large sums to develop convenient public recreational areas indicates the desire on the part of the people for such areas.

(j) To protect recreational investments and to permit present and future industries to have access to reasonably clean waters for industrial purposes, it is necessary to curb the tendency toward increased pollution of boundary waters and to eliminate much of the pollution now being added to these waters.

(k) Regional planning, embracing the areas tributary to the boundary waters, has been indicated as a definite need to expedite and facilitate the control of pollution.

(1) Evidence has been presented that the International Joint Commission should maintain a continuing interest in the condition of these boundary waters, and that an effective way should be found in which to exercise such interest.

Pollution Control Program

It is apparent, from the data presented in the foregoing, that a comprehensive waste treatment program is required. Two methods for dealing with water pollution problems are commonly advocated. One viewpoint advocates the utilization of the stream for carrying away as much waste as it can tolerate without interfering too seriously with normal stream uses. The other would exclude all impurities from watercourses. Between these conflicting views is a course which the Board feels will meet the situation. This course has been followed in developing the "Objectives for Boundary Waters Quality Control." No tolerance limit, whether for the effluent or for the stream, can be expected to remain fixed. It must change with changing conditions and each change should be in the public interest.

The large volume of water flowing between the United States and Canada should be regarded as a natural resource to be shared by both countries. It should not be wantonly destroyed by pollution from municipalities, from industries, or from any other source. An intelligent policy of safeguarding these waters from gross pollution should be fostered and encouraged so that they will be used for the highest public good and not exploited by selfish interests. While the boundary waters should not be regarded as public sewers for carrying away wastes of all kinds, their reasonable utilization for the disposal of wastes may be permitted as long as normal water uses are not impaired.

The pollution problem must be considered not only on the basis of present-day conditions but also in terms of the future. Facilities for the treatment of municipal sewage must incorporate sufficient flexibility to permit of ready expansion to satisfy future demands. Industrial waste disposal programs must not only provide adequate treatment for the present, but they must ensure that new industries or new industrial processes which may be established will not jeopardize the rights of users of these waters. Industry must continue to assume, in cooperation with other agencies, the research and planning required for satisfactory and efficient disposal of industrial wastes.

Disposal of Municipal Wastes

Since municipal sewage carries the organisms of diseases transmissible to humans, the discharge of this waste creates a major problem in the boundary waters. The large volume of municipal wastes, totalling 514 million U.S. (428 million Imp.) gallons per day, discharged into these waters adds a heavy bacterial load. About 80 percent of this is receiving some treatment, but the treatment in practically all cases is primary only. In addition to the domestic sewage from a contributing population of 2,483,500 in this section, the municipal sewers carry a considerable amount of industrial wastes. The effects of these industrial wastes are added to the bacterial load reaching the waters through municipal outfalls.

Since 1913 the population of this section has risen from a figure of less than 800,000 to nearly 2,600,000. The final report of the 1913 investigation pointed out that these waters were seriously polluted by sewage. It was recommended that the sewage be treated either by fine screening or sedimentation and, when necessary, by chemical disinfection in order to secure in the receiving waters a mean annual cross-sectional average B. coli of 500 per 100 c.c.

Since 1913 a number of sewage treatment plants have been constructed. Notwithstanding the accomplishments of these works, the bacterial load was found in 1946-1948 to be approximately three times as great as in 1913. The primary treatment of municipal wastes which has been provided has neither reduced the bacterial load below the 1913 level nor has it even kept pace with the increase resulting from expansion of municipal populations and industrial activities.

It can be anticipated that the population in the metropolitan areas will continue to increase. The city authorities have estimated that the Detroit sewage treatment plant will ultimately serve a population of four millions. Similarly, growths may be expected throughout the entire section. While primary treatment of sewage has been provided in a number of plants, many municipalities discharge raw or inadequately treated sewage. It is obvious that, as a first step, effective primary treatment by sedimentation and disinfection of the effluent should be undertaken immediately.

It is the opinion of the Advisory Board that satisfactory quality in these waters, as outlined in the "Objectives for Boundary Waters Quality Control," will not be obtained until all municipal wastes are given continuous treatment more effective than is now realized in primary treatment plants attempting to treat both domestic sewage and certain industrial wastes. More efficient or secondary treatment undoubtedly will have to be provided. It is recognized that local conditions on either side of the boundary may give additional impetus to the need for this higher degree of treatment. The completion of the construction of such works will require an appreciable length of time, but steps should be taken without delay to inaugurate this program. Highly objectionable conditions will continue at and below the points of effluent discharge from the larger centers until this more efficient or secondary treatment is furnished.

This program for the treatment of sewage will not accomplish the desired objective unless concurrent action is taken to deal with the overflows from combined sewers. These discharge large quantities of sewage and industrial wastes in times of heavy runoff. Generally, effective protection can be ensured by the use of adequate retention in sedimentation tanks followed by disinfection.

Similarly, the misuse or neglect of treatment facilities must be avoided at all times. Inefficient operation of the plant or bypassing of untreated or partially treated effluent must not be permitted.

The Board is of the opinion that reasonable stream sanitation consistent with the wide variety of uses of these waters, both present and future, will be maintained if the wastes are treated to a degree which will result in a median coliform M.P.N. value not exceeding 2,400 per 100 ml. at any point in the boundary waters following initial dilution of waste discharges. It will likewise be necessary to provide sufficient treatment that other substances which may injuriously affect the water, as defined in the objectives, will be removed.

Regional Sewerage Problems

Cooperation among the communities comprising a large center of population can be helpful in solving many mutual problems. The development of large metropolitan areas brings an increase in common governmental problems. Important among these are water supply and sewage disposal. Water distribution in such areas is generally less difficult than waste disposal. Fringe communities often must dispose of sewage through the major or parent community by virtue of natural drainage. Similar conditions may be true of the parent community discharging through other suburban areas of the drainage basin. Such regional problems are prominent at Detroit. Other areas on both sides of the boundary have problems of a similar nature.

A metropolitan or regional service for sewage disposal may be effected by one of two methods. Sewage disposal service may take the form of either contractual relations between the smaller communities and the larger one, or through the establishment of a quasi-municipal organization commonly known as a sanitary district. Experience in the United States has shown the sanitary district type of organization to be the more satisfactory for solving metropolitan sewerage problems. The usual enabling legislation authorizes revenue-producing powers in addition to normal governmental taxing ability and provides for equitable representation for the areas included. In Canada, both methods are being used successfully for providing water and sewerage services.

Reference has been made here to these methods of solving mutual sewage disposal problems in order that they may be considered in reaching a satisfactory solution in these areas of major populations.

Disposal of Industrial Wastes

The volume of industrial wastes, exclusive of that carried in municipal sewers, discharged directly into these boundary waters, is 1,430 million U.S. (1,191 million Imp.) gallons per day, nearly three times the volume of municipal wastes. As shown in table 16, chapter VII, these wastes carry large quantities of deleterious substances, which seriously affect the quality of the receiving waters and cause injury to health and property.

In contrast to the disposal of domestic sewage, industrial wastes are so varied in composition that no uniform treatment process is applicable. Each waste must be considered individually in the light of the deleterious substances present. Limits of tolerance for certain of these substances in industrial effluents have been included in the objectives for boundary waters quality control. The problem of industrial waste treatment is one for the industry involved.

When a new industry proposes to locate on a watercourse, due regard must be given to ensure that the wastes will not jeopardize the rights of other water users. The same principle must apply when new processes resulting in objectionable wastes are involved. This might properly take the form of approval by some public agency, a practice already in effect in both Michigan and Ontario.

One of the serious problems of industrial waste disposal is that of sudden or concentrated discharges, commonly known as "slugs" or "spills". By a slug is meant the release of a volume of highly concentrated polluting material over a short period of time. Slugs are intermittent, but their effects may be felt for great distances and for prolonged periods.

Slugs cause difficulty in producing an acceptable water supply. Since operators of water purification plants have no warnings of the approach of this material, some may enter the distribution system before adequate treatment can be applied. This situation presents a constant health hazard and may render the water unacceptable in other respects. For example, a sudden increase in the chlorine demand may result in a drinking water not properly disinfected. The worse offenders are industries using intermittent operations or other methods which result in periodic discharges. Slugs are usually due to deliberate discharge of waste materials, in contrast to spills resulting from accidents.

It is the responsibility of industry to avoid slugs and spills as far as possible. Retention tanks or lagoons should be provided where such conditions prevail, so that the discharges will be equalized.

Disposal of Other Wastes

Other wastes originate chiefly from navigation, dredging, and refuse disposal. While these wastes are of secondary importance they are significant in contributing to the pollution of boundary waters.

Vessels add pollution through the discharge of sewage, bilge water, and ballast water. They contribute bacterial pollution and oils to restricted areas, such as near water works intakes and bathing beaches. These discharges may also endanger the safety of water supplies taken aboard by other vessels while en route. This objectionable practice can be corrected by the use of sewage retention tanks accompanied by some form of sterilization of the contents. The tanks should be emptied either by transfer to shore treatment facilities or dumped overboard in non-restricted areas after adequate disinfection of the contents. This requirement should apply to commercial vessels equipped with flush toilets and to craft used for living purposes.

Much can be accomplished in reducing pollution from bilge and ballast waters by selecting non-restricted areas for their discharge. These restricted areas are or can be defined by legislation.

Dredging operations should involve the selection of dumping grounds which will not interfere with legitimate water uses, nor result in the transboundary travel of the dumped material.

Because garbage and other refuse cause unsightly conditions in water they should not be dumped either from shore points or overboard from vessels. Boats should provide facilities for storing this material for subsequent disposal on land. Local agencies should endeavor to control dumping from shore by careless persons.

PROGRESS IN POLLUTION CONTROL

Progress in the control or elimination of pollution has been substantial during the period of this investigation. Both municipalities and industries have contributed to this activity. Several factors have been responsible for this, such as availability of materials following termination of the war, stimulation by state and provincial authorities and interest of sportsmen's organizations, research into waste disposal methods, and the activities associated with this investigation. As an example, it may be noted that taste difficulties in municipal water supplies were much less pronounced at the conclusion of this study than prior to 1946.

While construction of sewage works has not been on a large scale there has been much activity in the preparation of plans and initiation of projects. Industrial waste treatment has made a pronounced advance. At the time of the hearings in 1948 it was estimated that industry had spent about $5,000,000 on corrective measures on both sides of the boundary since the initiation of the investigation. This activity is continuing on the part both of municipalities and industries.

Present Status of Municipal Waste Treatment

The present status of waste treatment programs for the Michigan municipalities is as follows:

St. Clair River Area

Municipality	Present Status
Port Huron	No treatment. Construction plans for interceptors and primary treatment completed. Under order of Michigan Supreme Court.
Marysville	No treatment. Construction plans for interceptors and primary treatment in progress.
St. Clair	No treatment. Construction plans for interceptors and primary treatment in progress.
Marine City	No treatment. Construction plans for interceptors and primary treatment in progress.
Algonac	No treatment. Report on corrective measures in progress.
	Lake St. Clair Area
New Baltimore	No treatment. Construction plans for complete treatment completed.
Mt. Clemens	No treatment. Construction of complete treatment facilities under way.

Municipality	Present Status
St. Clair Shores	To Detroit Plant. Construction plans for additional collection completed.
Roseville	To Detroit Plant.
East Detroit	To Detroit Plant. Increase in sewage interception under study.
Centerline	To Detroit plant. Additional interceptor needs under study.
Warren Township	To Detroit Plant. Construction plans for additional collection completed.
Grosse Pte.Woods	To Detroit Plant.
Grosse Pte.Shores	To Detroit Plant. Construction plans for additional collection completed.
Grosse Pte.Farms	To Detroit Plant.
Grosse Pte.	To Detroit Plant.
Grosse Pte.Park	To Detroit Plant.
	Detroit River Area
Detroit	Primary treatment with partial effluent disinfection in operation. Construction plans for additional interceptors completed. Construction of some interceptor facilities under way. Further treatment under consideration.
Highland Park	To Detroit Plant.
Hamtramck	To Detroit Plant.
Dearborn	Primary treatment without effluent disinfection in operation. No plans for plant enlargement or improved treatment.
Melvindale	No treatment. Construction plans for interceptors and primary treatment completed.
River Rouge	To Wyandotte Plant.
Ecorse	To Wyandotte Plant. Construction of additional collecting sewers under way.
Allen Park	To Wyandotte Plant.

Municipality	Present Status
Lincoln Park	To Wyandotte Plant.
Wyandotte	Primary treatment with effluent disinfection. No plans for plant enlargement. Construction plans for additional interceptors completed.
Riverview	To Wyandotte Plant.
Trenton	Primary treatment with effluent disinfection.

In Ontario the present status of the sewerage programs for the boundary municipalities is as follows:

St. Clair River Area

Municipality	Present Status
Sarnia	No treatment. Engineering report and preliminary plans completed for interceptor and primary treatment.
Sarnia Township	No treatment. Preliminary studies under way.
	Lake St. Clair Area
Wallaceburg	No treatment. Engineering report and preliminary plans completed for collection system and primary treatment.
Chatham	No treatment. Studies made for interceptors and sewage treatment.
	Detroit River Area
Tecumseh	No treatment. Engineering report and preliminary plans completed for sewers and treatment plant.
Riverside	Secondary treatment in operation.
Sandwich East Township	No treatment. Will be incorporated in greater Windsor system.
Sandwich West Township	No treatment. Will be incorporated in greater Windsor system.
Windsor	No treatment. Preliminary studies made on interceptors and sewage treatment.
Amherstburg	No treatment. No plans or report.

Present Status of Industrial Waste Treatment

The status of industrial waste treatment programs on each side of the boundary is presented below. This status is indicated by a key number as follows:

(1) Control measures provided.

(2) Control measures provided. Adequacy not demonstrated.

(3) Municipal sewerage facilities utilized.

(4) Studies, plans, or construction under way.

(5) No progress indicated.

* Actual construction under way.

In Michigan industries the status is as follows:

Industry	Class
Allied Chemical and Dye Corp., Barrett Division	
Oil Waste	(2)
Sewage	(3)
Phenol and others	(4)
Allied Chemical and Dye Corp., General Chemicals Div.	(4)
Allied Chemical and Dye Corp., Semet-Solvay Div.	
Sewage	(4)
Industrial Waste	(4)
Allied Chemical and Dye Corp., Solvay Process Div.	
Sewage	(4)
Industrial Waste	(2)
American Agricultural Chemicals Co.	
Sewage	(3)
Industrial Waste	(4)
American Brass Co.	
Sewage	(3)
Industrial Waste	(2)
Darling & Co.	
Sewage	(4)
Industrial Waste	(2)
Detroit Edison Co. (Marysville gas plant)	(2)

Industry	Class
Detroit Michigan Stove Co.	
Sewage	(3)
Industrial Waste	(3)
Detroit Sulphite Pulp and Paper Co.	
*Sewage	(4)
*Industrial Waste	(4)
Diamond Crystal Salt Co.	
Sewage	(4)
Industrial Waste	(2)
Dunn Paper Co.	
Sewage	(5)
Industrial Waste	(2)
E. I. DuPont de Nemours & Co., Electrochemicals Dept.	
Sewage	(3)
*Industrial Waste	(4)
E. I. DuPont de Nemours & Co., Grasselli Chemicals Dept.	
*Sewage	(4)
Industrial Waste	(1)
Firestone Rubber & Metal Products Co.	
Sewage	(3)
*Oil Waste	(4)
*Acid Waste	(4)
Ford Motor Co., Rouge Plant	
Sewage	(3)
*Acid Waste	(4)
*Oil Waste	(4)
*Cyanide Waste	(4)
*Phenol Waste	(4)
Franklin County Sugar Co.	(4)
Fuel Oil Corp.	(2)
Great Lakes Engineering Corp.	
Sewage	(5)
Oil	(2)
Great Lakes Steel Corp.	
*Sewage	(5)
Oil	(4)
Acid	(4)
Halowax Corp.	
Sewage	(3)
Acid Waste	(5)

Industry	Class
Michigan Consolidated Gas Co. Rouge Station	(2)
Michigan Consolidated Gas Co. Station A	(2)
Michigan Consolidated Gas Co. Station B	(2)
Monsanto Chemical Co.	
Sewage	(3)
Industrial Waste	(2)
Morton Salt Co.	
Sewage	(4)
Industrial Waste	(2)
Murray Corporation of America	
Sewage	(5)
Oil	(4)
Acid	(2)
Parke-Davis Co.	
Sewage	(3)
Industrial Waste	(2)
Peerless Portland Cement Co.	
Sewage	(3)
Industrial Waste	(5)
Pennsylvania Salt Co.	
Sewage	(3)
Industrial Waste	(2)
Port Huron Sulphite & Paper Co.	(4)
Pressed Metals Company of America	(5)
Reichhold Chemicals Inc.	(4)
Revere Copper & Brass	
Sewage	(3)
Industrial Waste	(4)
Sharples Chemicals, Inc.	
Sewage	(3)
Industrial Waste	(2)
Socony-Vacuum Oil Co.	(1)
U. S. Rubber Co.	
Sewage	(3)
Industrial Waste	(2)

Industry	Class
Werner G. Smith Co.	
Sewage	(3)
*Industrial Waste	(4)
Wyandotte Chemicals Corp., North Works	
*Sewage	(4)
Industrial Waste	(2)
Wyandotte Chemicals Corp., South Works	
Sewage	(4)
Industrial Waste	(2)

In Ontario the present status of industrial waste treatment programs is summarized as follows:

Dominion Salt Co.	
Sewage	(2)
Industrial Waste	(2)
Imperial Oil Limited	
Sewage	(4)
Oil Waste	(2)
*Phenol	(4)
Caustic	(1)
Mueller Limited	
Sewage	(4)
Cyanides	(2)
Chrome	(2)
Union Gas Co.	
Sewage	(4)
Oil	(4)
Phenols	(2)
Polymer Corp.	
Sewage	(2)
Oil	(2)
*Styrene	(4)
Caustic	(5)
Acid	(5)
Dow Chemical	
Sewage	(4)
*Industrial Waste	(4)
H. J. Heinz Co. of Canada Limited	
Sewage	(2)
Industrial Waste	(4)

Industry	Class
Sydenham Trading Co.	
Sewage	(2)
Cyanide	(2)
Wallaceburg Brass	
Sewage	(2)
Industrial Waste	(2)
Canada & Dominion Sugar Co. Limited (Wallaceburg Plant)	
Sewage	(2)
Industrial Waste	(4)
Canada & Dominion Sugar Co. Limited (Chatham Plant)	
Sewage	(2)
Industrial Waste	(4)
Darling and Company	
Sewage	(3)
Industrial Waste	(2)
Ford Motor Co. of Canada	
Sewage	(3)
Acid	(4)
Oil	(4)
Hiram Walker and Sons Limited	
Sewage	(3)
Industrial Waste	(4)
Canadian Industries Limited	
Sewage	(4)
Industrial Waste	(2)
Canadian Steel Corp.	
Sewage	(5)
Acid	(5)
Iron	(5)
Brunner Mond. (Canada) Limited	
Sewage	(5)
Industrial Waste	(5)
Calvert Distillers (Canada) Limited	
Sewage	(4)
Industrial Waste	(4)

COSTS AND FINANCING

The following estimates have been prepared on costs for remedial measures in answer to this question in the terms of reference. The municipal costs are divided as follows: (1) interceptors and primary treatment, (2) addition of secondary treatment. For industries the costs are estimated on the basis of compliance with the objectives for boundary waters quality control.

Costs for municipalities (interceptors and primary treatment):

United States side	$ 35,000,000
Canadian side	16,000,000
Total Municipal	$ 51,000,000

Costs for industries:

United States side	$ 13,000,000
Canadian side	3,000,000
Total Industrial	$ 16,000,000
Total	$ 67,000,000

For the second stage or secondary treatment of municipal wastes the additional costs are estimated as:

United States side	$ 33,000,000
Canadian side	4,000,000
Total	$ 37,000,000
GRAND TOTAL	$104,000,000

A strong deterrent in the solution of water pollution problems has been the reluctance of municipalities and industry to make funds available for this purpose. This may be due either to financial inability, lack of appreciation of responsibility by the polluter, or indifference on the part of the public. Accordingly, it is important to consider methods of securing funds for the construction and operation of remedial works.

Remedial works for treating municipal wastes must be constructed through public funds. These may come from any of several sources such as cash reserves, short term loans or debentures, general obligation bonds, special assessment bonds, revenue bonds, government aid, or any combination of these. The annual payments on capital debts incurred by the municipalities for such works and for their operation may come from general taxation or some form of service charge. Since the sewage works are designed for the benefit of the entire community and are an obligation of the municipality some municipal authorities favor paying part of the costs by general taxes. In order to apportion the remaining costs on the basis of benefits derived the practice of applying a service charge is gaining widespread use. These service charges are designated by several names such as sewer rates, sewage service rates, and sewer rentals. These rates have advantages which justify serious study by public officials confronted with the problem of financing municipal sewage treatment works.

It is a recognized fact that industrial wastes are the responsibilidy of the industry. Experience has demonstrated that in certain industries it is possible to reclaim from the wastes useful by-products which offset the cost of disposal. The treatment or control of these wastes, however, whether profitable or otherwise, must be regarded as a part of the cost of production.

LEGISLATION ON POLLUTION CONTROL

Legislation applicable to water pollution control was reviewed in chapter V. It defines Federal, State and Provincial, and municipal responsibilities and jurisdictions.

Federal legislation in the United States centers about Public Law No.845, passed in 1948, and known as the "Water Pollution Control Act." It was designed "to provide Federal technical services to State and interstate agencies and to industries, and financial aid to State and interstate agencies and to municipalities in the formulation and execution of their stream pollution abatement programs." There is also Federal legislation applicable to certain types of pollution entering harbors and other navigable waters.

In Canada there is no Federal legislation which is concerned with pollution of water per se. There are, however, certain statutes which deal with this problem, particularly as applied to navigation, fisheries, and wild life.

In the state of Michigan, pollution control is centered in the Water Resources Commission. The statute creating this agency gives authority to deal with all types of pollution.

In the Province of Ontario, legislation applicable to pollution control is contained in The Public Health Act and other enactments.

Municipalities are authorized to enact regulations or by-laws dealing with such local matters as control of pollution, restrictions on the use of sewers, setting sewer service rates, and financing.

THE CONTINUING PROGRAM

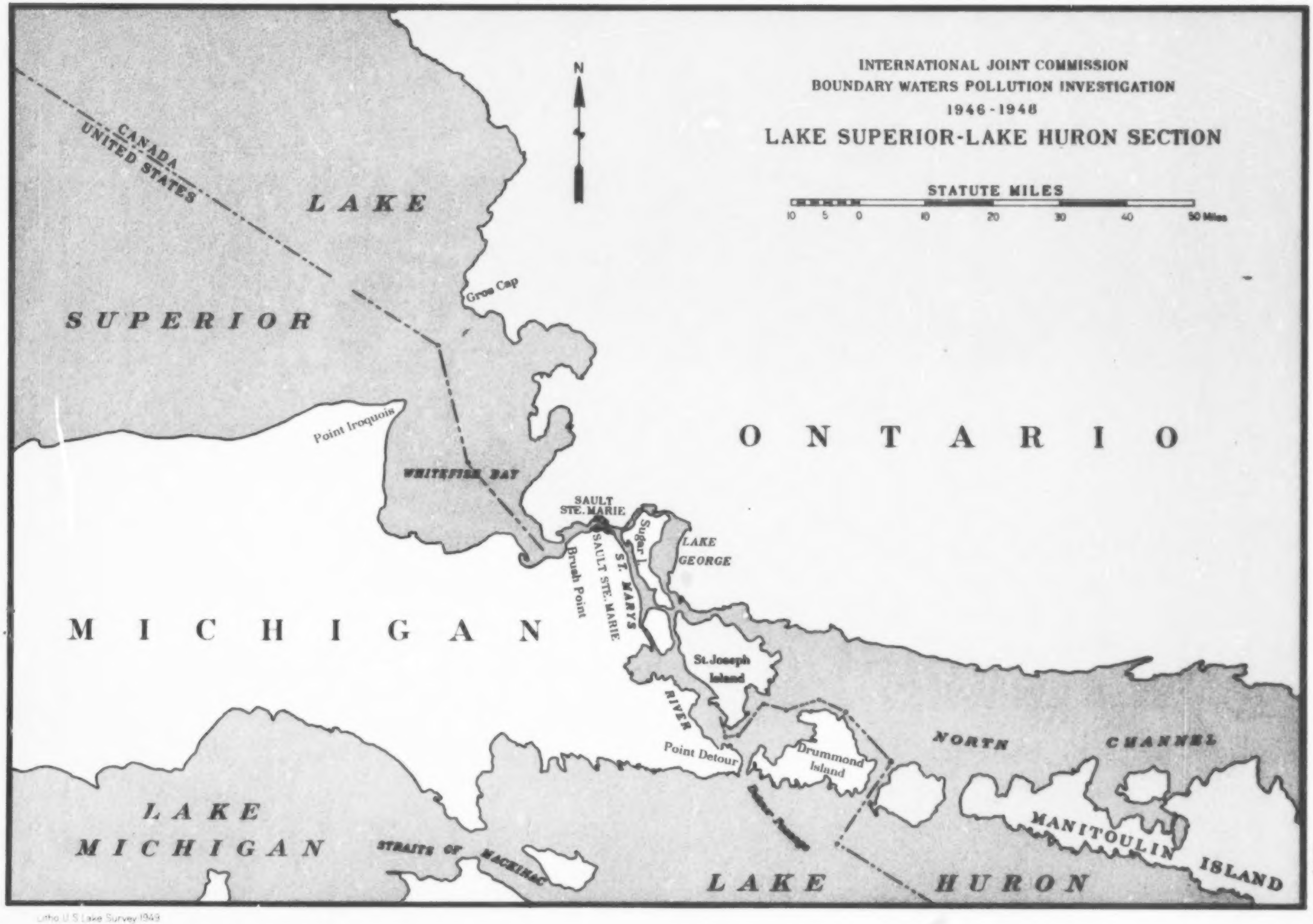
It is recognized that in these waters pollution control is an ever changing problem. The fulfillment of the objectives will require time and continuous supervision. Technical difficulties may be expected in connection with industrial wastes. New industrial processes which will be developed may produce different wastes and complications in disposal.

It is believed advisable for the Commission to foster pollution abatement programs for the boundary waters through consultation and cooperation with

Federal, State, and Provincial governments. The administration of such a program should be through existing pollution abatement authorities.

A spirit of cooperation in solving pollution problems has been evident, particularly among industries. Such cooperation has also been shown by the municipalities, but it has been less productive largely because of financial difficulties. Many large industrial concerns are undertaking their own pollution research and abatement programs on a national scale. Other industries have formed into groups or associations primarily for the development of waste treatment methods. Such groups include the Manufacturing Chemists Association of the United States, the American Petroleum Institute, the National Council for Stream Improvement (of the Pulp, Paper and Paperboard Industries) Incorporated, and the American Iron and Steel Institute.

It is believed that progress in pollution abatement will be aided if a technical committee or board be established to maintain a continuing interest in the pollution problem. Such a committee would supplement and strengthen the efforts made by local authorities and would permit the interchange of reports on progress. This committee should consist of representatives from the Federal, State, and Provincial governments involved in this problem.



INTERNATIONAL JOINT COMMISSION
BOUNDARY WATERS POLLUTION INVESTIGATION
1946-1948

LAKE SUPERIOR-LAKE HURON SECTION

STATUTE MILES
10
5
0
10
20
30
40
50 Miles
N
CANADA
UNITED STATES
LAKE SUPERIOR
Gros Cap
Point Iroquois
WHITEFISH BAY
SAULT STE. MARIE
SAULT STE. MARIE
Brush Point
ST. MARYS RIVER
Sugar I.
LAKE GEORGE
St. Joseph Island
Point Detour
Drummond Island
ONTARIO
MICHIGAN
NORTH CHANNEL
MANITOULIN ISLAND
LAKE HURON
LAKE MICHIGAN
STRAITS OF MACKINAC

Litho U.S. Lake Survey 1949

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LAKE SUPERIOR - LAKE HURON SECTION

1946-1948

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CHAPTER SM-I

FINDINGS AND RECOMMENDATIONS

The investigation of pollution in the boundary waters of the Lake Superior - Lake Huron section has extended over the period of July 1947 to July 1948. In that time a comprehensive examination was made of all phases of pollution, and relevant information was obtained from several sources. These data have been studied and conclusions reached on the questions contained in the terms of reference to the International Joint Commission by the governments of the two countries.

The investigation has enabled the Board of Technical Advisers to reach certain conclusions on the findings and to offer recommendations to the Commission for remedial measures. The findings of the Board are summarized herewith.

FINDINGS

1. These waters are polluted in many places on both sides of the boundary. The most serious pollution occurs in the river from the locks to the head of Sugar Island and in the Lake George Channel.
2. There is a transfer of pollution from each side of the boundary to the other. This occurs chiefly in the Lake George Channel.
3. There has been injury to health and property on both sides of the boundary. This has been manifested in the following ways:
    a. Health - A potential hazard exists where waters polluted to the extent of these are used for domestic purposes. The present raw water supplies on both sides

of the boundary are relatively free from heavy bacterial pollution but cannot be used without complete and continuously effective treatment. Much of the threat to health arises from such factors as variations in pollution with accompanying erratic chlorine demand, interference of certain types of pollution with disinfectants which destroy their germicidal properties, and the probability of certain infections being carried through a treatment process if there is any interruption or breakdown in a part of that process.

These waters are so polluted in certain areas as to render them unsafe for bathing purposes. This hazard is not only associated with typhoid fever and other reportable diseases, but it may include enteric, ear and upper respiratory infections.

The sewage pollution present in these boundary waters must be considered as an actual and potential health hazard, whether it be through public water supplies, bathing beaches, or other vehicles.

b. Property - Injury to property has been illustrated in the deposition of solids of waste origin on waterfront property, interference with the development of bathing beaches and other water front property, additional cost of water treatment and fouling of shore areas by oil.

4. Limited progress has been made toward the control of pollution during the period of this investigation.
5. Public hearings held by the Commission revealed a common acceptance, on the part of municipal officials and industrial management, of the presence of pollution in these waters and the need for correction. Financing of the necessary remedial works was asserted by municipal officials to be the principal obstacle to correction.
6. The condition of these waters requires that remedial measures be undertaken as early as possible.

RECOMMENDATIONS

The Advisory Board respectfully offers the following recommendations to the Commission:

1. Remedial measures for the abatement and control of pollution in the Lake Superior - Lake Huron section of the boundary waters be undertaken at the earliest possible date. These measures should be sufficient to restore and protect the uses of these waters to which the people of both countries are rightfully entitled. Major consideration should be given to uses for domestic and industrial water supplies, recreation, fish and wildlife, sanitary purposes, and navigation.
2. Treatment of municipal wastes by sedimentation and disinfection of the effluent be undertaken by both municipalities as the initial step. The estimated cost for installation of intercepting sewers and primary treatment works for the

two municipalities in this section is $4,000,000 of which $1,250,000 is on the United States side and $2,750,000 on the Canadian side.

3. Industrial wastes be treated to comply, as soon as possible, with the "Objectives for Boundary Waters Quality Control." The estimated cost for industrial waste treatment works is $500,000 of which $150,000 is for United States and $350,000 for Canadian industries. The problem of industrial waste disposal is the responsibility of industry.
4. Slugs and spills of objectionable wastes from industrial plants be avoided by the installation of retention tanks or lagoons with provision for equalizing rates of discharge.
5. Sewage from vessels equipped with flush toilets and from craft used for living purposes be controlled by the installation of holding tanks, and that the tanks be emptied either by transfer of the contents to shore treatment facilities or dumped overboard in non-restricted areas after disinfection. Bilge and ballast waters be discharged only in non-restricted areas. No garbage or other refuse be discharged overboard into these waters.
6. The "Objectives for Boundary Waters Quality Control," prescribed in this report be recognized in the development of remedial and pollution-preventive measures by municipalities and industry. These objectives should apply to both existing and new sources of wastes.
7. Definite plans for financing remedial municipal works be formulated. In this, there should be cooperation between

the Commission and Federal, State, Provincial, and municipal governments.

8. Continuing contact with pollution control progress be maintained through a technical committee or board having representation from both countries.
9. The Commission take such measures as may be legally available to it to have the pollution abatement and prevention program herein outlined initiated, promoted, and effectively prosecuted.

CHAPTER SM-II

INITIATION OF THE INVESTIGATION

THE POLLUTION PROBLEM

In the 1913 investigation all sections of the boundary waters were included, from the Lake of the Woods on the west to the St. Lawrence River on the east. In the present investigation only parts of the boundary waters are involved, particularly those contiguous to large centers of population or major industrial developments. The discharge of untreated municipal and industrial wastes which appeared to have international significance, precipitated this investigation of the St. Marys River.

AUTHORIZATION OF SURVEY

The reference covering the St. Marys River is an extension of the reference to the Commission on the St. Clair River, Lake St. Clair and the Detroit River. The terms of reference, dated October 2, 1946, are the same as those for the Lake Huron - Lake Erie section. The Commission, accordingly, requested the same Board of Technical Advisers to extend their investigational activities to this section of the boundary waters. This territory is designated in this report as the Lake Superior - Lake Huron section.

ORGANIZATION FOR LAKE SUPERIOR - LAKE HURON INVESTIGATION

Field work on the Lake Superior - Lake Huron section was initiated in July 1947. The personnel for this work was supplied by Federal, State and Provincial agencies, the same as for the Lake Huron - Lake Erie section.

Field laboratories were established at Sault Ste. Marie, Ontario, and at Sault Ste. Marie, Michigan. The entire section was examined by both field parties in close co-operation. Field studies included sampling and analysis of the boundary waters, visual examination, and investigation of industries and other sources of pollution. Special examinations and studies were made in the laboratories of the Ontario Department of Health at Toronto and of the U. S. Public Health Service at Cincinnati, Ohio.

The general laboratory techniques and procedures followed were the same as those used for the Lake Huron - Lake Erie section. The number of samples collected and analyses made are listed in table SM-1.

Table SM-1 - SAMPLES COLLECTED AND ANALYSES MADE

Area or Source	Bacteriological Examinations	Chemical Examinations	
		Samples	Determinations
Upper St. Marys River	679	533	2,939
Lower St. Marys River	1,602	1,426	7,371
Municipalities	214	214	214
Industries	-	50	342
Total	2,495	2,223	10,866

Selection and Designation of Sampling Points

The same principles were followed in the selection of sampling points as in the Lake Huron - Lake Erie section. The 1913 sampling points were used and others added as the situation required.

The river mileage index system was employed to designate the locations of sampling ranges, sewer outlets, and other important points on the river. These reference points refer to the zero mileage point established by the U. S. Corps of Engineers at the upstream end of the United States locks at Sault Ste. Marie. All distances were taken as either upstream or downstream from this point. The letters used for designation of ranges are SMU for upstream and SMD for downstream from the zero point.

CHAPTER SM-III

GENERAL DESCRIPTION AND HYDROMETRIC DATA

The drainage basin of the Lake Superior - Lake Huron section embraces a relatively small and sparsely settled region on both sides of the International Boundary. It drains an area of 1,949 square miles, with 808 in the United States and 1,141 in Canada. Numerous small streams drain into the river along its course, but none of them is of sufficient importance to warrant special discussion. The geographical features of the area are shown in figure SM-1.

ST. MARYS RIVER BASIN

St. Marys River is the connecting waterway between Lake Superior and Lake Huron. It flows from Lake Superior in an easterly direction to Sault Ste. Marie and then southeasterly to Lake Huron. The upper river section is short, extending from Whitefish Bay to St. Marys Falls, a distance of 14 miles. This section of the river varies in width from 18,000 feet at Whitefish Bay to 2,000 feet at the falls and has channel depths ranging from 25 to 55 feet. The falls of the St. Marys River are about 3/4 mile long and 1/4 mile wide, and the drop ranges from 18 to 24 feet with varying stages of water surface.

Since 1797, when the first lock was built on the Canadian side, a series of works has been constructed on both the United States and Canadian sides of the falls, as aids to navigation and for power development. These works include dredged channels, locks, power diversion canals and regulating gates at the head of the rapids.

Below the falls, the river to Lake Huron consists of a series of interconnected lakes and bays which form an irregular shore line. This section of the river extends for a distance of 49 miles from the locks to Detour Passage via the main vessel route through Lake Nicolet Channel and about 61 miles via Lake George

Channel. The lower river contains three large islands, Sugar and Neebish Islands on the United States side, and St. Joseph Island on the Canadian side. These split the flow of the river into the various channels. Early navigation was through the Lake George Channel, although the available depth was only 4 to 5 feet. The other channels were closed to navigation by the Neebish Rapids which were shallow and full of rocks. The Lake George Channel, largely in Canadian waters, has been abandoned and a nearly continuous channel improvement project has been completed by the United States through Lake Nicolet and the Middle and West Neebish Channels. Vessel traffic now uses this latter route almost exclusively.

The area on the Canadian side, draining to the section of the St.Marys River from Lake Superior to Lake George, is relatively narrow and reaches from 8 to 10 miles inland. The area draining into the river below Lake George comprises the much greater portion of the entire drainage basin. This portion extends inland a maximum distance of approximately 45 miles.

Natural drainage on the United States side flows to the St. Marys River in several small streams which have their headwaters only a few miles inland. The largest of these tributaries is the Munuscong River, which drains a local watershed extending to a depth of about 15 miles inland. These tributaries are of no commercial importance and hence require no dredging. They have primary value as recreational areas and are retained in their original state as wildfowl refuges.

TOPOGRAPHY

The area in Ontario which borders the St. Marys River is a drift-covered strip, varying from one to five miles in width. In the central and west portion it rises toward the north in a succession of clay, sand,

and gravel terraces. It reaches a maximum altitude of about 400 feet above mean water surface elevation of 602.2 feet in Lake Superior. The area to the north of the lower terraced section rises to an altitude of 420 feet above mean water surface elevation of 579.8 feet in Lake Huron. On the United States side the topography is characterized by gradually rising terrain from the river to the inland headwaters. Extending westward beyond the headwaters of the tributaries, the rising terrain develops into a flat area which is generally less than 300 feet above the bordering lakes.

GEOLOGY

The St. Marys River came into existence in comparatively recent times. In preglacial time the outflow from the Superior basin was south from Whitefish Bay. It passed through a channel near the present village of Rudyard to St. Martin Bay and joined Spencers Laurentian River north of Bois Blanc Island. During the early postglacial period Lake Superior stood at the same elevation as Lake Michigan - Huron, the connection being a broad strait in the present St. Marys valley. Differential movement in the crust of the earth finally raised the rock ledge at Sault Ste. Marie above the level of Lake Huron, and the strait became the St.Marys River.

The rock formations of the area range from pre-Huronian to Cambrian. The oldest series consist of steeply tilted schists, which are intruded by granite and diabases, also pre-Huronian in age. The hard rock formations of the area are manteled and, in places, are deeply buried beneath a covering of drift. This, in turn, is overlain by lake clays, silts, sands, and gravels. The latter cover the lowlands and extend up the slopes to a height of over 400 feet in western Ontario.

CLIMATE

The climate of the region is subject to considerable variation, similar to and gravel terraces. It reaches a maximum altitude of about 400 feet above mean water surface elevation of 602.2 feet in Lake Superior. The area to the north of the lower terraced section rises to an altitude of 420 feet above mean water surface elevation of 579.8 feet in Lake Huron. On the United States side the topography is characterized by gradually rising terrain from the river to the inland headwaters. Extending westward beyond the headwaters of the tributaries, the rising terrain develops into a flat area which is generally less than 300 feet above the bordering lakes.

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CLIMATE

The climate of the region is subject to considerable variation, similar to that of the Lake Huron - Lake Erie section. However, the mean annual temperature is about 10°F. lower than that in the more southerly part. The proximity of Lakes Superior, Michigan, and Huron tempers the climate decidedly along their shores. This is especially true of the narrow strip along the south shore of Lake Superior. The typical North American cold wave, which so frequently sweeps down from the northwest and is attended by strong northwest winds, is tempered in severity as it crosses the wide stretches of comparatively warm water. The temperature is often raised from 15° to 20°F. in this way, so that the region immediately bordering Lake Superior does not experience the extremely low temperature conditions that are common further inland.

The average annual temperature at Sault Ste. Marie, Michigan, for 55 years of record, was 38.1° F. The extremes range from 98° to minus 37° F., with an average temperature in February of 11.5° F. and an average temperature in July of 62.7° F. The average annual precipitation, for 52 years of record, at this location was 29.88 inches, with a maximum of 41.02 and a minimum of 20.69 inches. The greater portion of this precipitation falls during the growing season. One characteristic of the weather along Lake Superior is the heavy snowfall. This averages more than 100 inches per winter, while at Sault Ste. Marie it averages 80 inches. The prevailing winds are from the northwest for eight months of the year, February through September, and from the southeast for four months, October through January. The average hourly velocity of the prevailing winds was 8.6 miles. A maximum velocity of 56 miles per hour was recorded with a northwest wind in February 1889.

POPULATION

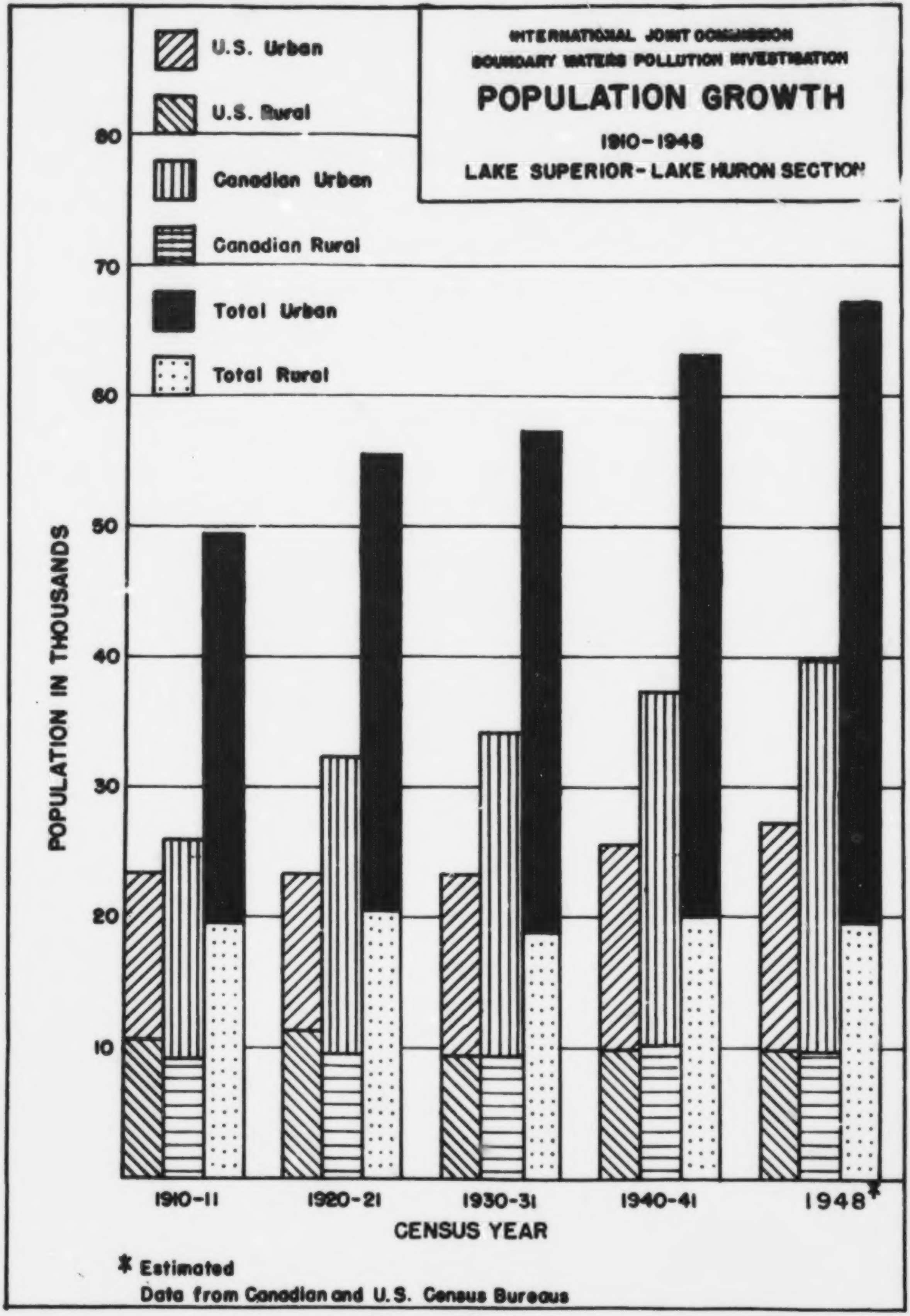
The population in the drainage basin of the St. Marys River, given in the 1940 U. S. Census and 1941 Canadian Census, was 63,000. More recent estimates (1948) indicate a population increase of about 2,600 on the Canadian side and 1,500 on the United States side since 1940. This makes the present estimated population in the area over 67,000. Figure SM-1 shows the growth in population between 1910 and 1948.

Sault Ste. Marie, Michigan, and Sault Ste. Marie, Ontario, are the two principal population centers in the area. In 1948 the combined estimated population of these two cities was 47,000, about two-thirds of the total population in the drainage basin. The rural population is distributed in small villages with less than 1,000 persons and in isolated homesteads throughout the township areas. The population density in 1948, expressed in persons per square mile, was about 35 in both the United States and Canadian areas and for the entire basin.

LAND USE AND DEVELOPMENT

The Upper Peninsula of Michigan, including the eastern portion in the St.Marys River basin, was originally covered with heavy forests of pine and hardwoods. A great part of these forests has been cut away. Early development in the area was due principally to the lumbering activities. Construction of the locks and other facilities related to the improvement of the St. Marys River as a commercial waterway also contributed to the growth. Early development of hydroelectric power plants on both sides of the St. Marys Falls resulted in the growth of an industrial area. The major industries in the area include a steel mill, a pulp and paper mill, a tar and chemical plant, carbide manufacturing, and leather processing plant.

The cut-over land surrounding the centers of population has been developed for agriculture. The principal agricultural crops are hay, small grains, and potatoes. Lumbering operations are still carried on in the virgin timber area to the northeast of Sault Ste. Marie, Ontario. In more recent years, limited operations have been renewed in the second-growth timber areas of the Upper Peninsula in Michigan. Sugar



INTERNATIONAL JOINT COMMISSION
BOUNDARY WATERS POLLUTION INVESTIGATION
POPULATION GROWTH
1910-1948
LAKE SUPERIOR - LAKE HURON SECTION

* Estimated
Data from Canadian and U.S. Census Bureaus

Figure SM-1

Island is wooded and rocky and has numerous summer cottages along its shore. St. Joseph Island has been developed primarily for agriculture. Both of these islands are linked to the mainland by car ferries.

HYDROMETRIC DATA

The discharge of the river is now subject to regulation and the flow is varied according to water level requirements. Since the development of hydroelectric power plants on both sides of St. Marys Falls, the portion of the total flow diverted for power purposes is so controlled as to maintain a required level in Lake Superior and also to maintain adequate channel depths for navigation purposes in the lower river. When the water surface of Lake Huron is high, the current in St. Marys River is checked. When a large flow is passed from Lake Superior, the current is strong and is further increased if the level of Lake Huron is low.

River discharge data, compiled by the U. S. Lake Survey, show the flow averaged 72,600 c.f.s. for the 48-year period 1900-1947. In the upper section, above the falls, the current velocities are less than 1 mile per hour. Below the falls the swiftest currents in the navigable channels are found in the Middle Neebish dike, the West Neebish rock cut, and the Little Rapids cut. Velocities in these channels are usually 1½ to 2 miles per hour but vary from a low of 1 mile to a high of 3 to 3½ miles per hour. The present fall from the foot of the rapids to Lake Huron averages about 1½ feet. Under present conditions the Lake George Channel carries about 32 percent of the river flow, with the remainder passing down the Lake Nicolet and Neebish Channels.

CHAPTER SM-IV

USES OF BOUNDARY WATERS

The waters in the Lake Superior - Lake Huron section of the boundary are used for a variety of purposes. The order of precedence to be given to these uses is stated in Article VIII of the treaty of 1909 between the two countries. These waters serve for domestic and sanitary purposes, navigation, power and irrigation. Other uses are for industrial process water, recreation, and for support of fish and wildlife. Irrespective of the uses made, the treaty requires that these boundary waters shall not be polluted on either side to the injury of health or property on the other side.

DOMESTIC WATER SUPPLY

The waters of the upper St. Marys River are the sources of supply for the cities of Sault Ste. Marie. The water is not filtered but is chlorinated at both cities. On the Ontario side ammonia is used for control of chlorophenolic tastes. A portion of the Canadian city is supplied with well water, and about 45,000 persons in the two cities are supplied with water from the river. The total average pumpage for each plant is:

Canadian	-	2.7 M.G.D. (Imp.)
United States	-	5.5 M.G.D. (U.S.)

Much of the water from the Michigan plant goes to industry. The industries on the Ontario side pump their own process water. No public water supplies are taken from the lower St. Marys River.

SANITARY PURPOSES

The river is used for the disposal of the untreated domestic sewage from the entire population of both cities. It reaches the river through numerous outlets, nearly all of which are below the locks.

NAVIGATION

Vessel traffic through this section is very heavy. In the 1947 season of navigation the vessel passages amounted to 22,270, passengers carried 90,500, and total tonnage carried 83,300,000 tons. These waters are used for disposal of all sanitary wastes from these vessels. At times, vessels are forced to anchor close together, both above and below the locks, thereby imposing a more concentrated pollution load on the river.

POWER AND IRRIGATION

The water is used for power purposes on both sides of the boundary. This affects the currents in the river but it does not add pollution.

INDUSTRIAL USES

Industry in this area uses the boundary waters for process, steam power, cooling and sanitary purposes, in addition to that taken from public supplies. The water so pumped from the river for industrial uses amounted to 98 million U.S. (82 million Imp.) gallons. This water is returned to the river as waste through independent plant outlets.

RECREATIONAL USES

The many lakes and bays in the lower river provide areas with excellent bathing possibilities, but these have been developed only to a limited extent. The only public recreational development along the lower river, within easy reach of the city populations, is the municipal park east of Sault St. Marie, Ontario. This park is deprived of bathing privileges because of pollution. A public park is located on the Michigan side near the upper city limits and above the locks, but bathing is limited. There is private bathing in all parts of the river other than in the immediate vicinity of the two cities.

Boating and fishing are popular forms of recreation throughout the entire area. While bathing is restricted to a comparatively short season because of low water temperature, fishing is continued almost the year round.

LEGISLATION

Legislative authority for control of pollution in this section is the same as that in the Lake Huron - Lake Erie section.

CHAPTER SM-V

WATER-BORNE DISEASES

Consideration has been given to the incidence of typhoid fever and dysentery in relation to water pollution. In the appendix to the Progress Report of the International Joint Commission dated January 16, 1914, it is stated that the typhoid fever rates were high in both cities. When Sault Ste. Marie, Michigan, took its water supply from just above the locks in the old ship canal, its typhoid fever rate paralleled that of Sault Ste. Marie, Ontario. When it moved the intake to a location well above the city, its rate fell markedly below that of the Ontario city. In the winter, the typhoid fever rate dropped to almost nil but rose strikingly during the months of navigation. In Sault Ste. Marie, Ontario, typhoid was present in winter as well as summer. These facts were taken as an illustration of the disastrous effect of slight intermittent pollution and pollution from boats. At that time neither city had chlorination of its water supply.

Both city water supplies from the river have been chlorinated for many years, and a marked reduction in typhoid fever rates has occurred. Similar pollution exists today, but chlorination is the protective barrier against water-borne disease. The typhoid fever death rate, accordingly, is no longer an index of the sanitary quality of this water. Table SM-2 shows the statistics on typhoid fever deaths from 1913 to 1949.

Table SM-2 - TYPHOID FEVER MORTALITY

Total Deaths and Death Rates per 100,000 Population

Municipality	1913		1920		1930		1940		1947	
	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate
State of Michigan	558	17.5	300	8.2	89	1.8	11	0.2	5	0.08
Sault Ste.Marie *	3	24.1	0	0	1	7.3	0	0	0	0
Province of Ontario	446	16.7	203	7.0	76	2.3	26	0.7	6	0.1
Sault Ste.Marie *	16	124.0	3	13.9	0	0	0	0	0	0

CHAPTER SM-VI

SOURCES AND CHARACTER OF POLUTION

Pollution entering the boundary waters in this section originates principally from domestic and industrial sources at Sault Ste. Marie, Michigan, and Sault Ste. Marie, Ontario. Both the municipal and industrial sewers discharge untreated into the St. Marys River through multiple outlets. Pollution from tributaries is relatively unimportant as such streams are small and drain only rural areas and unsewered communities.

There are 5 major industrial plants located in the district, 2 of them in the United States and 3 in Canada. Detailed studies were made of the character and volume of wastes procuced at the 3 Canadian plants. The wastes from 1 industrial process on the United States side were considered of little significance, and no studies were made. In the other industry, information obtained from State records and from engineering conferences was deemed sufficient.

Vessels engaged in freight and passenger traffic in this section also constitute a source of pollution. Itr significance is indicated by the fact that the canals at Sault Ste. Marie handle, during the navigation season, twice the yearly tonnage of the Panama Canal.

DOMESTIC WASTES

The principal source of sewage pollution is the domestic wastes discharged from both cities through combined sewers into the St. Marys River, mostly below the locks. This sewage is untreated and enters the river at numerous outlets on both sides of the boundary. Both cities have fairly complete sewer systems, but there are no interceptors along the waterfront.

The 1948 estimated combined population for the two principal municipalities is shown in table SM-3. Excluding rural and unsewered municipal areas, the contributing population is approximately 45,500.

Table SM-3 - PRINCIPAL SOURCES OF DOMESTIC WASTES -

LAKE SUPERIOR - LAKE HURON SECTION

Municipality	Receiving Stream	Population		Sewage Treatment
		Total(Est.) 1948	Served by Sewers	
Sault Ste. Marie, Ont.	St. Marys R.	29,700	28,200	None
Sault Ste. Marie, Mich.	St. Marys R.	17,300	17,300	None
Total		47,000	45,500	

The estimated volume of untreated sewage from these two municipalities is shown in table SM-4.

Table SM-4 - VOLUME OF MUNICIPAL WASTES

Area	Volume - Gallons per Day	
	United States	Imperial
United States side	3,500,000	2,910,000
Canadian side	3,120,000	2,600,000
Total	6,620,000	5,510,000

Other sources of sewage pollution exist above and below the cities of Sault Ste. Marie. These include the unsewered portions of both cities and summer cottages and water front residences not connected to any public sewer system.

In the upper river, on the Michigan side, there are private outfalls and a septic tank overflow from a State institution. On the Ontario side, summer resorts and waterfront residences contribute pollution. In the lower river several small hotels, encampments, and Pavignon Creek draining the Bayview area of Sault Ste. Marie, Ontario, discharge sewage to the river.

The disposal of garbage and other refuse in both cities is not a contributing factor to the pollution problem. On the Michigan side disposal is by dumping and burial at inland points. On the Ontario side incineration is employed in a municipally operated plant. No garbage has been used as fill material on river front lots.

INDUSTRIAL WASTES

Sources of industrial waste pollution in the Lake Superior - Lake Huron section are concentrated in that part of the river extending from about one-half mile below the locks to 2-1/2 miles upstream. The industries contributing wastes are as follows:

Canada:

Dominion Tar & Chemical - Oils, phenols.

Algoma Steel Corporation - Ammonium compounds, phenols, oils, cyanides, solids, iron, acids.

Abitibi Power & Paper Company - Solids, B.O.D., sulphite liquors.

United States:

Northwestern Leather Company - Solids, B.O.D., phenols.

Union Carbide and Carbon Corporation - Solids.

The summary of industrial wastes discharged into the St. Marys River is shown in table SM-5.

Table SM-5 - SUMMARY OF INDUSTRIAL WASTES DISCHARGES

	Quantity Discharged Daily		
	Canada	United States	Total
Wastes:			
MGD (U.S.)	146	2.4	148.4
MGD (Imp.)	122	2.0	124.0
Phenols - Pounds	280	0	280
Ammonium Compounds - Pounds	48,000	0	48,000
Cyanides - Pounds	3,170	0	3,170
Oils: Gals. (U.S.)	1,020	0	1,020
Gals.(Imp.)	850	0	850
B.O.D. - Pounds	217,900	7,800	225,700
Pop. Equiv. - Persons	1,282,000	46,000	1,328,000
Suspended Solids - Pounds	75,000	4,800	79,800

On the Canadian side, phenols result from coking operations at the steel company's plant and from the by-products tar plant associated with it. An unknown amount is discharged on the United States side above the locks in the vicinity of the Northwestern Leather Company's outfall. Approximately 96 percent of the 280 pounds of phenol discharged daily on the Canadian side enters the river below the locks. The balance is discharged intermittently and adversely affects the quality of the Sault Ste. Marie, Ontario water supply. There is also a possibility of accidental spillage of oils and phenols. The steel plant discharges ammonium compounds at a computed amount of 48,000 pounds a day. Cyanides from this same source, in the coking operations, are computed at 3,170 pounds per day. Oils discharged amount to 850 Imperial gallons per day, and are carried in the steel corporation's trunk sewer discharging below the locks. The biochemical oxygen demand of the industrial wastes amounted to 225,700 pounds daily, having a population equivalent of 1,328,000 persons. The suspended solids in the industrial wastes reached the high figure of 79,800 pounds daily, consisting largely of iron dust and paper fibre.

WASTES FROM NAVIGATION

The character of wastes contributed to boundary waters from vessels has been discussed at length in chapter VII of the Lake Huron-Lake Erie section report. The pollution from this source is equally significant in the St. Marys River. The estimated wastes from vessels in this section are 30,000 U.S. (25,000 Imp.) gallons per day, or an average population of 1,000 persons, and 500 pounds of garbage. Bilge and ballast waters also are factors in the pollution of these waters.

CHAPTER SM-VII

POLLUTION EFFECTS ON BOUNDARY WATER QUALITY

Evaluation of the quality of the waters of the St. Marys River was made from the examination of water samples collected from representative sampling points above and below the major sources of pollution. In addition to the bacteriological and chemical analyses, a special study was made of river bottom deposits and floating debris for the purpose of judging the distribution of industrial wastes originating on both sides of the river.

Field studies were carried on during the summer and fall of 1947 and the spring of 1948, during which time a total of 2,495 bacteriological and 10,866 chemical determinations were made in laboratories established for this purpose in both cities. The laboratory examinations used were similar to those employed in the Lake Huron - Lake Erie section. An explanation of these tests is given in detail in chapter VIII of that report.

ANALYTICAL RESULTS OF THE 1913 INVESTIGATION

In the 1913 investigation pollution was attributed largely to the discharge of domestic sewage from municipalities and vessels. Little cognizance was taken of industrial wastes, which have since assumed much greater importance. Thus the problem encountered in the earlier investigation is not entirely comparable with that of the present.

The St. Marys River at that time was considered by the sanitary experts to be of dangerous bacterial quality and unfit for use as a municipal water supply without adequate treatment. The extent of pollution in the upper St. Marys River was measured at 3 sampling ranges located above the water works intake of Sault Ste. Marie, Michigan. The first sampling range extended from Gros Cap to a point above Bay Mills. Pollution was most marked in the ship channel, with average numbers of B. coli per 100 c.c. ranging between 11 and 13. This was attributed to boat traffic since sampling points midway between the ship channel and the shore indicated B. coli values of less than 3 per 100 c.c.

The second range was located between Brush Point, on the United States side, and Point aux Pins, on the Canadian side. Average B. coli ranged from 13 to 22, being fairly evenly distributed throughout this narrow cross section.

The third range, located just above the intake at the Sault Ste. Marie, Michigan, water works, showed practically the same degree of pollution as at the previous range.

Samples taken from cross sections below the municipal outfalls showed gross pollution which extended, practically undiminished, to Neebish Island. Below this point the degree of pollution showed a marked decrease, with isolated B. coli counts up to 20 per 100 c.c. near shore points, but the general numbers varied from 0 to 4. In the narrows at Detour Passage low values of 0 to 4 were obtained, with an occasional count as high as 20.

The maximum B. coli values were found immediately below the two municipalities of Sault Ste. Marie, where counts as high as 640 occurred near the Canadian shore, 340 at United States shore points. Both the east and west channels at the head of Sugar Island showed B. coli from 200 to 400 per 100 c.c., whereas values at the lower end of the island varied from 25 to 250. The pollution was general throughout the river in both channels.

The fact that pollution was found to be common to both channels may be regarded as significant in respect to transboundary movement.

The bacteriological results as discussed above are given in terms of the Phelps Index. To convert to the Most Probable Number (M.P.N.) system, as used during the 1946-1948 investigation, the Phelps Index number should be multiplied by 2.4.

ANALYTICAL RESULTS OF THE 1946-1948 INVESTIGATION

A summary of the analytical results of samples taken during the present investigation is presented in table SM-6. The table includes the mediar bacterial values as well as the average chemical and physical figures. Maximum and minimum values and the number of samples taken at each sampling point are also shown. The coliform and phenol results are shown in figures SM-3 and SM-4.

In the upper St. Marys River four principal sampling ranges were established, two of which were at approximately the same locations as used in 1913. The first of these, range SMU-15.5, was located at Whitefish Bay, from Gros Cap to Point Iroquois. The median M.P.N. coliform index per 100 ml. was generally less than 2.3, with a high median of 12 close to the International Boundary and the navigation channel.

The second range, SMU-5.6, located in the narrows between Brush Point and Point aux Pins, showed median M.P.N. values between 3.6 and 7.8, indicating a slight increase over the previous range. In one case the maximum M.P.N. value reached 350 at a point 500 feet from the United States shore.

The third and fourth ranges, SMU-1.8 and SMU-1.0, located in Ashmun Bay, start below the Northwestern Leather Company and run to Old Vessel Point and the Algoma Steel Corporation dock, respectively, on the Canadian shore. Coliform results in midstream ranged from less than 1 to a median value of 9.1. Median shore values increased in the vicinity of industrial outlets. On the United States shore the median and maximum M.P.N. values were 17 and 350, respectively. At the Canadian end of range SMU-1.0 the median and maximum values were 94 and 920, respectively. One sampling point in the polluted back eddy above the Algoma Steel Corporation's boat slip showed median and maximum M.P.N.

values of 230 and 4,600, respectively.

Some high M.P.N. values were found in a series of short sampling ranges near the Northwestern Leather Company's outfalls. Although a maximum M.P.N. of 11,000 occurred at the No. 2 outfall, no such concentration was found in the samples of range SMU-1.0, a short distance below.

In the lower St. Marys River a much higher degree of bacterial pollution existed, due to the discharge of domestic and industrial wastes. Pollution from the many municipal outfalls on both sides tends to hug the shores to a point where the river divides at Sugar Island. This is illustrated by median coliform values which ranged from 930 to 4,600 on the United States side, from 23 to 43 in midstream, and from 4,600 to 5,400 on the Canadian side. At the head of Sugar Island on range SMU-3.1w, M.P.N. values in the west or Lake Nicolet Channel varied from 220 near shore to 93 near the island. In the east or Lake George Channel, at range SMD-4.2e, values ranged from 3,500 at the Canadian shore to 280 at Sugar Island. Beyond this range the Lake George Channel narrows and is turbulent, causing a mixing and uniform distribution of the bacterial load across the stream. This uniform distribution of coliform values persisted at the same magnitude as far as the entrance to Lake George, at range SMD-14.2e, showing a median value of 930 per 100 ml. Through Lake George, a distance of 11 miles, there is a gradual reduction in numbers until at the outlet (range SMD-25.0e) the median values varied from 13 to 23.

A similar trend was observed in the Lake Nicolet Channel, where uniform distribution and reduction in M.P.N. values occurred. Median values of 300 near the mainland and 93 at midstream and at the Sugar Island shore were found at the entrance to Lake Nicolet, on range SMD-5.3w. M.P.N. values were found to be 150 in the West Neebish Channel and 79 in the

Middle Neebish Channel, on ranges SMD-18.1w and SMD-16.9m, respectively. A comparable value was found in the shipping lane of the international or Munuscong Channel, between Neebish Island and St. Joseph Island.

Bacteriological samples taken in the Canadian waters between St. Joseph Island and the mainland, at range SMD-30.0e, showed an increase in coliform values over those of the ranges immediately upstream. No reason is apparent for this rise in M.P.N. values from 23 to 460 in the centers of these channels.

Maximum coliform values, considerably higher than the medians, occurred throughout the whole area. Values as great as 110,000 were found below main sewer outfalls at Sault Ste. Marie, on the Canadian side and 92,000 on the United States side. The maximum values fell off rapidly with a high of 24,000 occurring at the head of Sugar Island and only 4,600 at the entrance to Lake George. The highest value at the lower end of Lake George was 930 as against a median of 23. The heavy concentration of bacterial pollution is carried down the Lake George Channel rather than the Lake Nicolet Channel.

A comparison of coliform results in the upper St. Marys River for the 1913 and 1946-1948 investigations reveals no substantial change. The figures for 1946-1948 are somewhat lower but the difference is not significant, and the bacterial quality continues to be normal for such surface waters. Whether this slight difference in pollution is due primarily to a reduction in passenger traffic is not clear.

In the lower river, below the municipal sewer outfalls at range SMD-2.0, the coliform pollution is now approximately twice as great as in 1913. In the Lake George Channel it continues at about this same ratio. In the Lake Nicolet Channel the present figures show a lower coliform value than in 1913. Similarly, at the farthest downstream ranges the coliform values are less now than they were in the previous investigation.

In the 1913 investigation the over-all increase in coliform pollution in this section was roughly 6 times. In the present investigation the increase is 33 times. Both of these increases are influenced by the effects of natural purification agencies. The increase in coliform values from above the locks to the range of maximum pollution today is over 400 times. In 1913 this increase was only 17 times.

Chemical analyses of samples taken in the upper St. Marys River showed a pattern of pollution similar to that indicated by the bacteriological examinations. Determination of phenols was the most significant for indicating industrial pollution. Phenols averaged less than 3 p.p.b., with the exception of a few shore points. A point 100 feet from shore, below the No. 2 tannery outfall of the Northwestern Leather Company, showed an average of 43 p.p.b. with a maximum of 350 p.p.b. Samples in the small bay upstream from the Algoma Steel Corporation's boat slip gave an average phenol content of 16 and maximum of 50 p.p.b.

The highest average concentration of phenols below the locks was found at the Canadian shore in the first sampling range, SMD-0.8, and amounted to 27 p.p.b. On the average, only a trace occurred in the balance of the range. One mile farther downstream the samples showed an average phenol content of 18 p.p.b. for the shore point and a tendency toward dispersion across the stream. There was no evidence that phenols originating on the Canadian side crossed the International Boundary into the Lake Nicolet Channel at Sugar Island. Rather, the analytical results showed that these phenols traveled down the Lake George Channel and continued moderatly high along the Canadian shore for a total distance of 8 miles below the locks. Beyond this point they were dispersed throughout the stream. While an average concentration of 4 p.p.b. remained at the entrance to Lake George, passage through the lake accomplished a reduction to trace proportions of the same magnitude as found in the upper river.

In the upper river a maximum phenol value of 350 p.p.b. was found in the vicinity of the tannery outfall. A high maximum value of 80 p.p.b. occurred in the Canadian side in the lower river at range SMD-0.8. At the entrance to Lake George the maximum was 45 p.p.b. Occasional values of 15 p.p.b. were found at shore points on the United States side for a distance of 18 miles below the locks through the Lake Nicolet and West Neebish Channels.

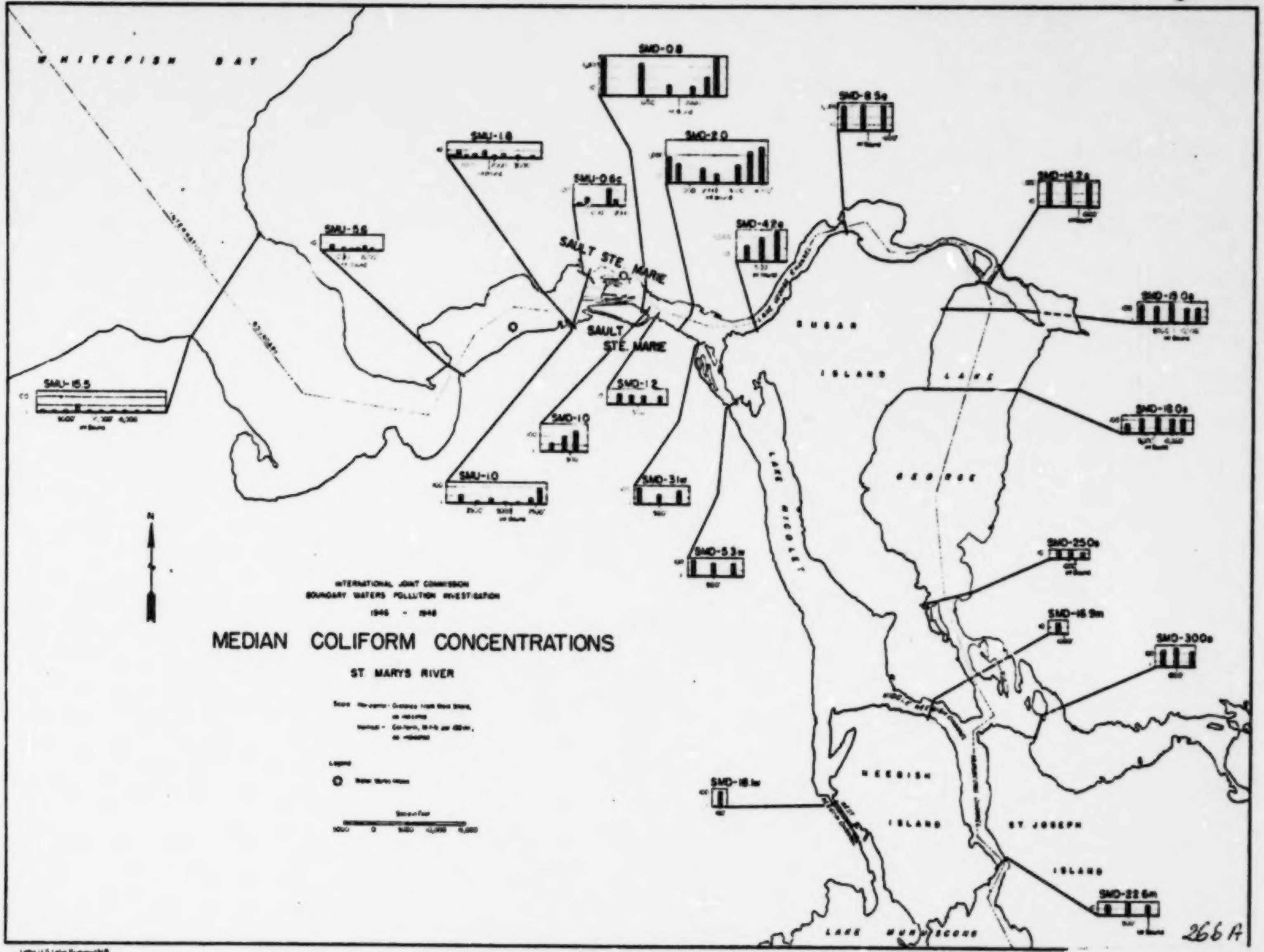
Dissolved oxygen and B.O.D. values in the upper river, with the exception of shore points influenced by industrial wastes, did not reveal any material effect of pollution. Dissolved oxygen values were normal, averaging from 9.5 to 12.5 p.p.m. in the main stream, with no serious depletion in the polluted shore areas. The biochemical oxygen demand was consistently low, less than 1 p.p.m., except in the immediate vicinity of the tannery outlets, where average values varied from 2 to nearly 10 p.p.m., with a single maximum of 37 p.p.m.

The highest B.O.D. values occurred at shore points immediately below both cities, ranging from an average of 0.86 p.p.m. to 2.3 p.p.m., with a value of 0.57 p.p.m. in midstream. A slightly higher than normal B.O.D. was noticeable throughout the Lake George Channel. Normal B.O.D. values in unpolluted sections of the upper St. Marys River were from 0.40 to 0.75 p.p.m. as compared to 0.90 p.p.m. in Lake George and 0.60 p.p.m. in the Munuscong Channel.

Somewhat lower B.O.D. values were found in the Lake Nicolet Channel. The average near the head of Sugar Island was 0.85 p.p.m., reducing to 0.45 p.p.m. in Lake Nicolet. It is significant that higher values occurred in the narrow navigation channels on both sides of Neebish Island.

No variation in dissolved oxygen could be attributed to pollution, with the exception of the shallow shore area opposite lower Sault Ste. Marie, Ontario. In this small area the current is slow, and the deposition of sewage and industrial waste solids on the river bed has created anaerobic conditions.

Turbidity values in the river were usually well below 10 p.p.m., with a maximum at one shore point of over 40 p.p.m. Alkalinity results were fairly constant, averaging between 41 and 48 p.p.m. Hydrogen ion concentrations averaged between 7.5 and 7.9.



WHITEFISH BAY
SMU-15.5
SMU-5.6
SMU-1.8
SMU-1.0
SMU-0.6c
SMD-0.8
SMD-2.0
SMD-1.0
SMD-1.2
SMD-3.1w
SMD-4.7e
SMD-5.3w
SMD-8.5e
SMD-14.2e
SMD-15.0e
SMD-18.0e
SMD-25.0e
SMD-15.5m
SMD-30.0e
SMD-18.1w
SMD-22.6m
SAULT STE MARIE
SAULT STE. MARIE
SUGAR ISLAND
LAKE GEORGE
LAKE NICOLET
NEEBISH ISLAND
ST JOSEPH ISLAND
LAKE MUNUSCONG
N

INTERNATIONAL JOINT COMMISSION
BOUNDARY WATERS POLLUTION INVESTIGATION
1946 - 1948

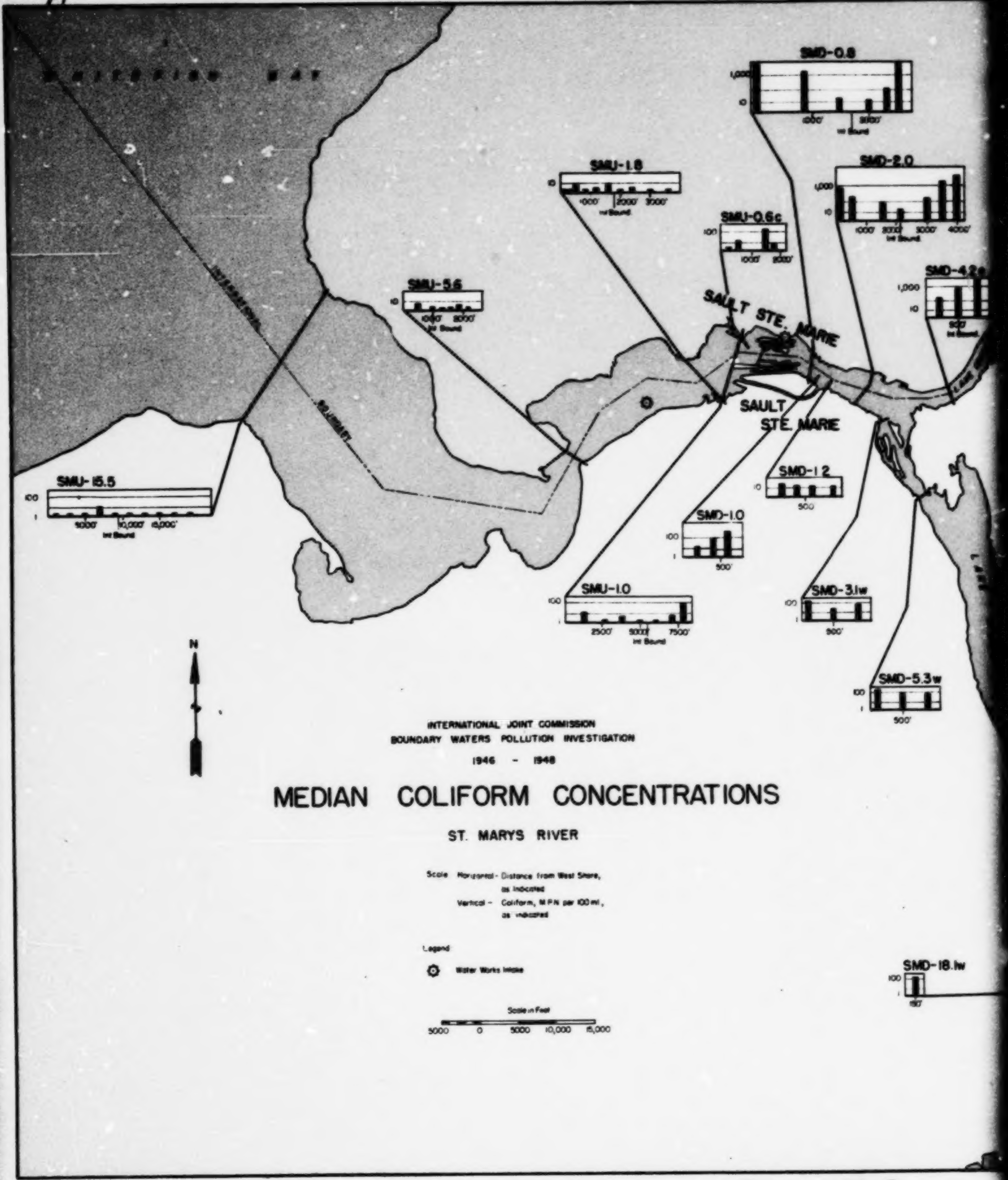
MEDIAN COLIFORM CONCENTRATIONS

ST MARYS RIVER

266 A

Figure SM-2

A


WHITEFISH BAY
INTERNATIONAL
BOUNDARY
SMD-0.8
1,000
10
1000'
2000'
Int Bound
SMU-1.8
10
1000'
2000'
3000'
Int Bound
SMD-2.0
1,000
10
1000'
2000'
3000'
4000'
Int Bound
SMU-0.6c
100
1000'
2000'
SMD-4.2e
1,000
10
500'
Int Bound
SMU-5.6
10
1000'
2000'
Int Bound
SAULT STE. MARIE
SAULT
STE. MARIE
SMU-15.5
100
1
5000'
10,000'
15,000'
Int Bound
SMD-1.2
10
500
SMD-1.0
100
1
500'
SMU-1.0
100
1
2500'
5000'
7500'
Int Bound
SMD-3.1w
100
1
500'
SMD-5.3w
100
1
500'
SMD-18.1w
100
1
150'
N
LAKE

INTERNATIONAL JOINT COMMISSION
BOUNDARY WATERS POLLUTION INVESTIGATION
1946 - 1948

MEDIAN COLIFORM CONCENTRATIONS

ST. MARYS RIVER

Scale Horizontal - Distance from West Shore, as indicated
Vertical - Coliform, MPN per 100 ml, as indicated

Legend

⚙ Water Works Intake

Scale in Feet
5000 0 5000 10,000 15,000

Litho U.S. Lake Survey 1949

Figure SM-2

B

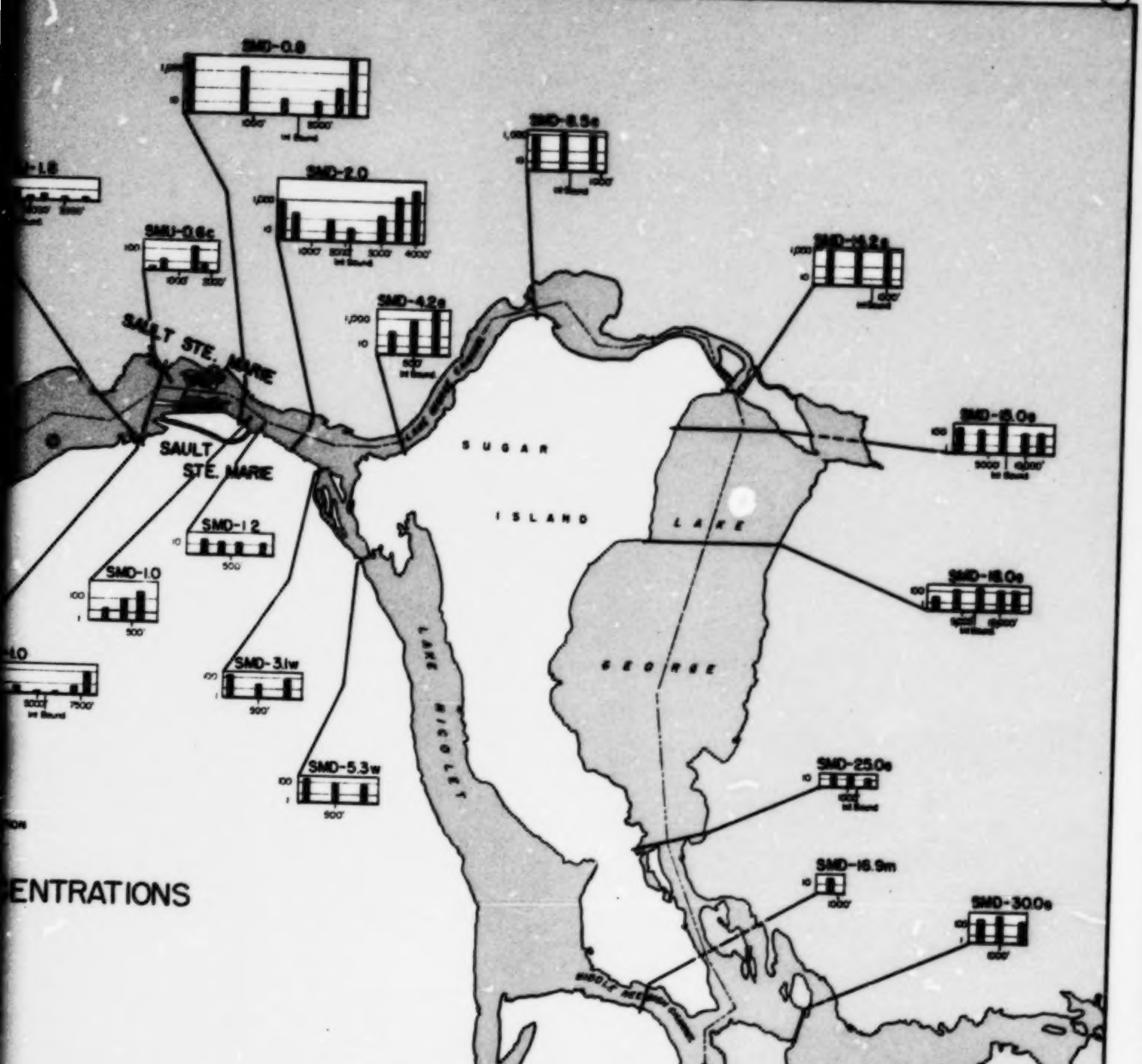
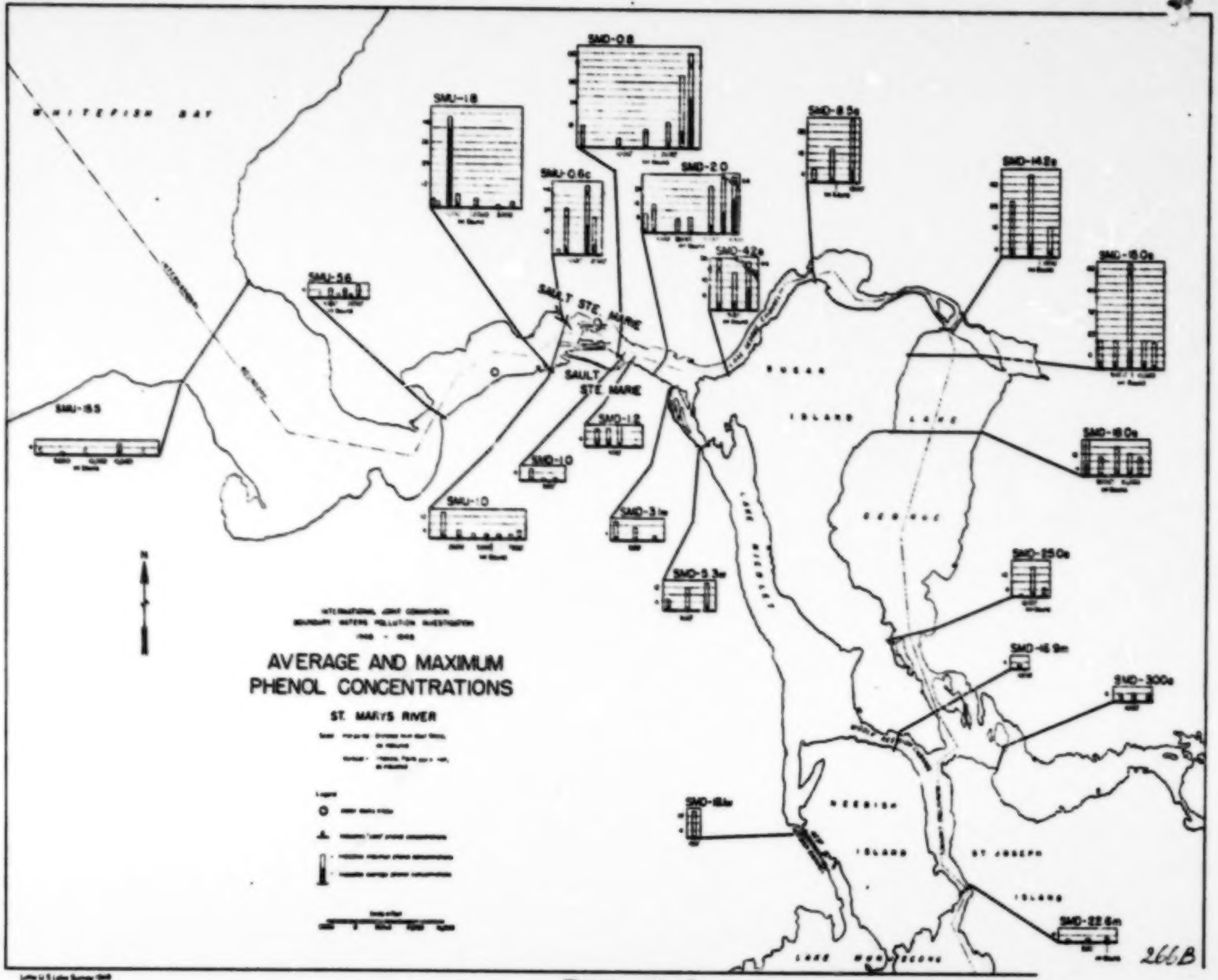

SMD-0.8
SMD-1.8
SMD-2.0
SMU-0.6c
SMD-6.5e
SMD-14.2e
SMD-4.2e
SAULT STE. MARIE
SAULT
STE. MARIE
SMD-1.2
SMD-1.0
1.0
SMD-3.1w
SMD-5.3w
SMD-15.0e
SMD-18.0e
SUGAR
ISLAND
LAKE
GEORGE
LAKE
NICOLET
SMD-25.0e
SMD-16.9m
SMD-30.0e
NEEBISH
ISLAND
ST. JOSEPH
ISLAND
SMD-18.1w
WEST NEEBISH CHANNEL
SMD-22.6m
LAKE MUNUSCONG
ENTRATIONS

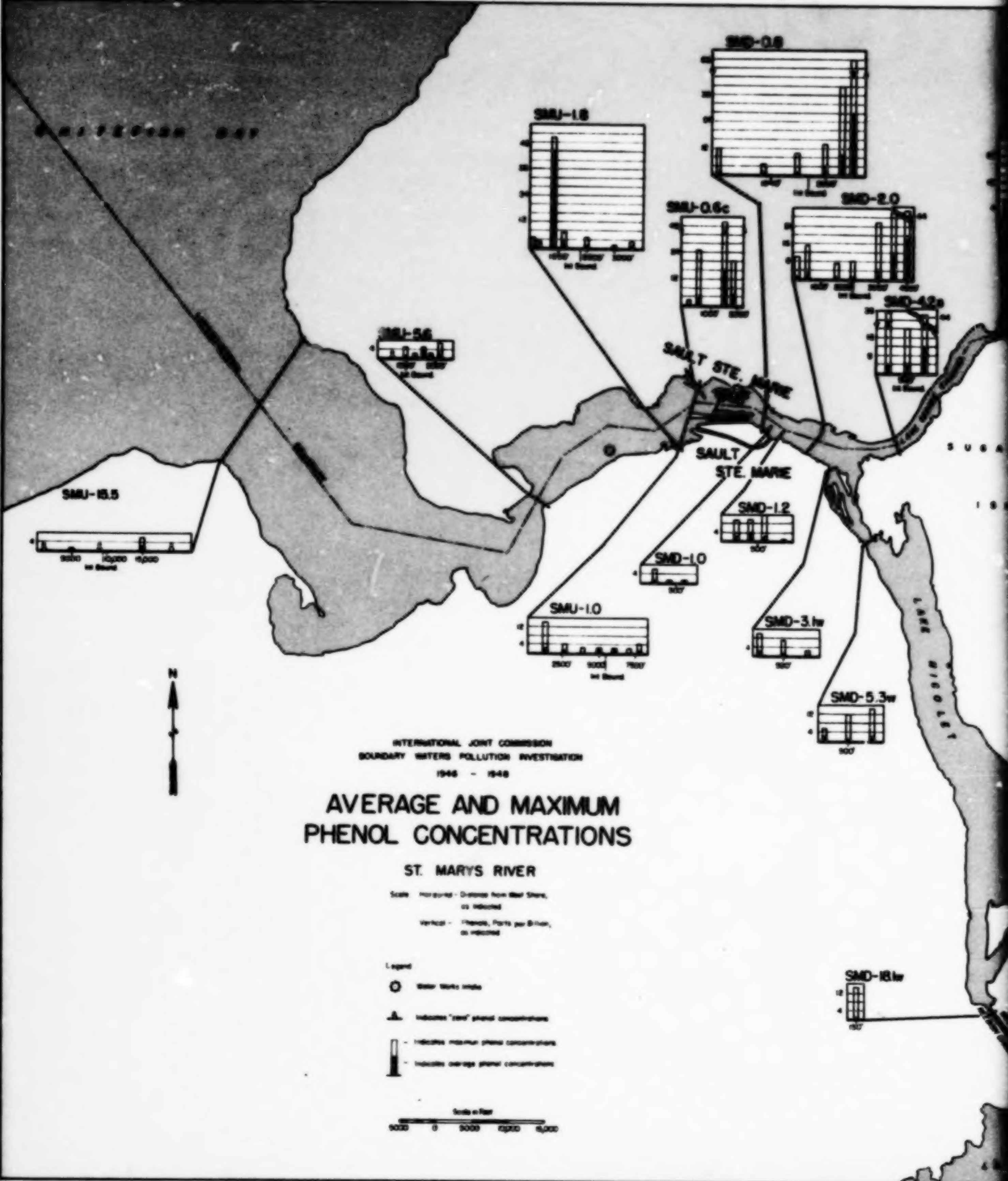
Figure SM-2


INTERNATIONAL JOINT COMMISSION
BOUNDARY WATERS POLLUTION INVESTIGATION
AVERAGE AND MAXIMUM
PHENOL CONCENTRATIONS
ST. MARYS RIVER
Legend
N
WHITEFISH BAY
SAULT STE MARIE
SAULT STE MARIE
SUGAR ISLAND
LAKE GEORGE
LAKE NICOLET
NEEBISH ISLAND
ST JOSEPH ISLAND
LAKE MUNUSCONG
SMU-15.5
SMU-5.6
SMU-1.8
SMU-1.0
SMU-0.6c
SMD-0.8
SMD-1.0
SMD-1.2
SMD-2.0
SMD-3.1w
SMD-4.2e
SMD-5.3w
SMD-8.5e
SMD-14.2e
SMD-15.0e
SMD-18.0e
SMD-25.0e
SMD-16.9m
SMD-30.0e
SMD-18.6w
SMD-22.6m

Litho U S Lake Survey [illegible]

Figure SM-3

A


WHITEFISH BAY
SMD-0.8
SMU-1.8
SMU-0.6c
SMD-2.0
SMD-4.2a
SMU-5.6
SAULT STE. MARIE
SAULT
STE. MARIE
SMU-15.5
SMD-1.2
SMD-1.0
SMU-1.0
SMD-3.1w
SMD-5.3w
SMD-18.1w
LAKE NICOLET
SUGAR
ISLAND
N
Int. Bound.
5000
10,000
15,000
2500
7500
12
4

INTERNATIONAL JOINT COMMISSION
BOUNDARY WATERS POLLUTION INVESTIGATION
1946 - 1948

AVERAGE AND MAXIMUM PHENOL CONCENTRATIONS

ST. MARYS RIVER

Scale Horizontal - Distance from West Shore, as indicated
Vertical - Phenols, Parts per Billion, as indicated

Legend
○ Water Works intake
Indicates "zero" phenol concentrations
Indicates maximum phenol concentrations
Indicates average phenol concentrations

Scale in Feet
5000 0 5000 10,000 15,000

Litho U.S. Lake Survey 1949

Figure SM-3

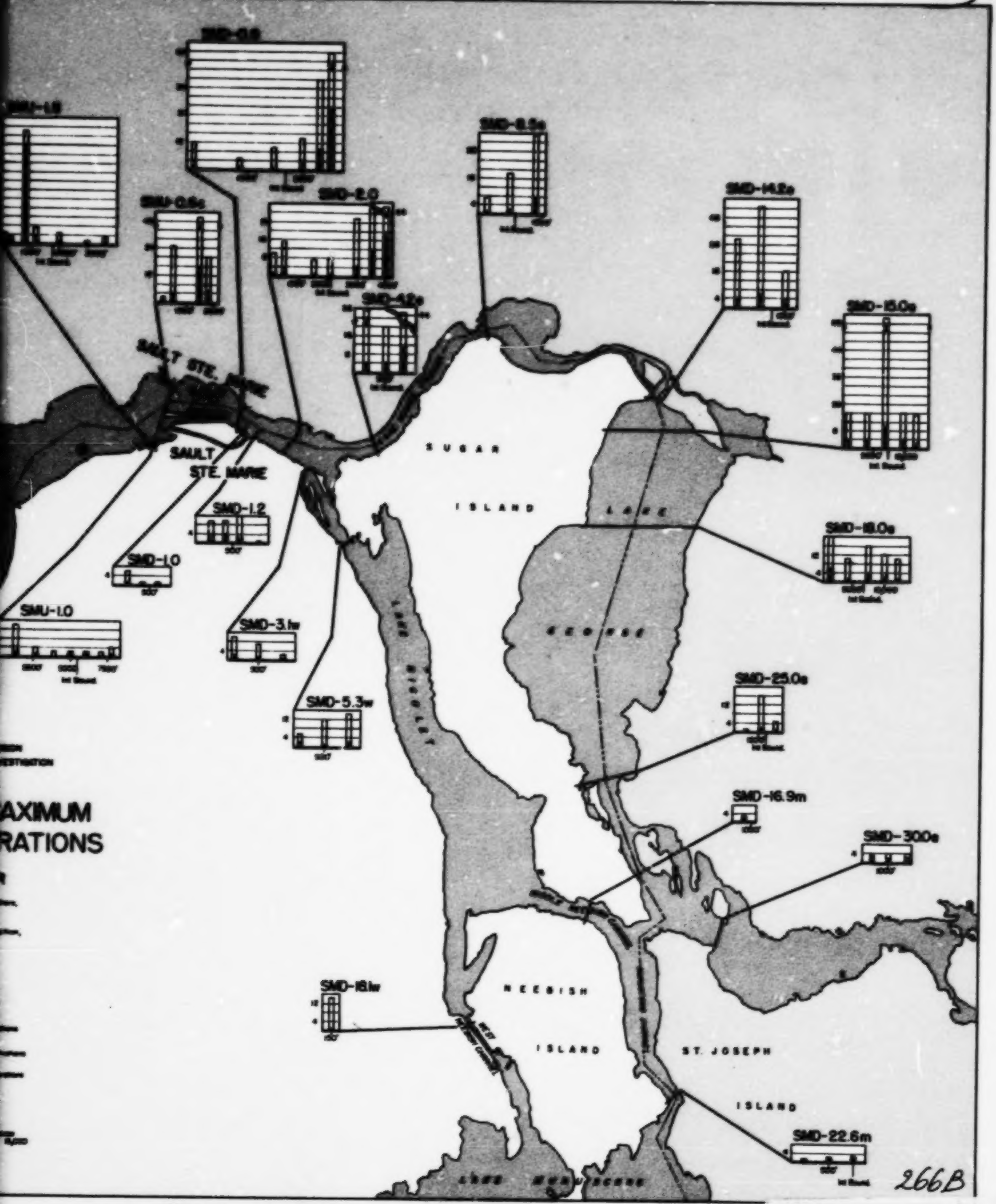

SMD-0.9
SMU-1.8
SMU-0.9c
SMD-2.0
SMD-6.5e
SMD-4.2e
SMD-14.2e
SMD-15.0e
SAULT STE. MARIE
SAULT
STE. MARIE
SUGAR
ISLAND
LAKE
GEORGE
SMD-1.2
SMD-1.0
SMU-1.0
SMD-3.1w
SMD-18.0e
SMD-5.3w
LAKE NICOLET
SMD-25.0e
SMD-16.9m
SMD-30.0e
AXIMUM
RATIONS
SMD-18.1w
NEEBISH
ISLAND
ST. JOSEPH
ISLAND
SMD-22.6m
LAKE MUNUSCONG
Int. Bound.

Figure SM- 3

(Follows page 263)

Table SM-6 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – ST. MARYS RIVER

Sampling Point	Mileage Index No.	Feet from U.S. Shore		Coliforms M.P.N. per 100 ml.	Phenols ppb	Chlorides ppm	pH	Alkalinity ppm	Turbidity ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm
Point Iroquois, Mich. across to Gros Cap, Ont. (at Head of St. Marys River near Whitefish Bay).	SM-15.[illegible]	1000	Average	(Median) < 1.8	0	2.8	7.9	44	0.7	13.0	10.5	0.93
			Maximum	2.3	0	5.2	8.0	48	1.2	18.0	13.3	3.50
			Minimum	1.8	0	2.1	7.6	40	0.4	5.5	[illegible]	
			No. of Samples	15	3	9	9	9	7	5	10	8
		3000	Average	(Median) < 2.3		2.2	7.5	45		16.0	10.2	0.36
			Maximum	< 2.3		2.2	7.6	47		17.0	10.5	0.53
			Minimum	< 2.3		2.2	7.4	43		15.0	9.9	0.20
			No. of Samples	2		2	2	2		2	2	2
		5000	Average	(Median) < 1.8	1	2.1	7.7	45		16.0	10.4	0.43
			Maximum	< 2.3	1	2.1	7.7	45		17.0	10.4	0.46
			Minimum	< 1.8	0	2.0	7.7	44		15.0	10.3	0.40
			No. of Samples	5	3	2	2	2		2	2	2
		7000	Average	(Median) 12		2.1	7.7	45		15.5	10.4	0.40
			Maximum	23		2.3	7.7	46		16.0	10.4	0.40
			Minimum	< 2.3		1.9	7.7	44		15.0	10.4	0.40
			No. of Samples	2		2	2	2		2	2	1
		9000	Average	(Median) 1.8	0	2.3	7.8	42	0.9	12.0	11.6	0.97
			Maximum	3.6	0	3.0	7.9	46	1.5	16.5	13.3	3.10
			Minimum	< 1.8	0	2.0	7.7	40	0.4	5.0	10.4	0.30
			No. of Samples	5	3	5	5	5	3	5	5	5
		9500		INTERNATIONAL BOUNDARY								
		11,000	Average	(Median) < 1.8		2.6	7.8	45	0.5	16.0	9.9	0.47
			Maximum	22		7.0	8.0	46	1.2	17.0	10.7	0.83
			Minimum	< 1.8		1.9	7.6	44	0.2	15.0	9.2	0.00
			No. of Samples	11		7	8	7	5	2	7	5
		13,000	Average	(Median) < 2.3		2.1	7.7	45		16.0	10.4	0.52
			Maximum	< 2.3		2.2	7.7	46		17.0	10.5	0.58
			Minimum	< 2.3		2.0	7.6	44		15.0	10.3	0.46
			No. of Samples	2		2	2	2		2	2	2
		15,000	Average	(Median) < 1.8	2	2.1	7.7	45		16.0	10.5	0.50
			Maximum	< 2.3	6	2.1	7.7	45		17.0	10.5	0.57
			Minimum	< 1.8	0	2.1	7.6	44		15.0	10.4	0.44
			No. of Samples	5	3	2	2	2		2	2	2
		17,000	Average	(Median) < 2.3		2.1	7.7	45		16.0	10.3	0.44
			Maximum	< 2.3		2.1	7.7	46		17.0	10.4	0.48
			Minimum	< 2.3		2.1	7.7	44		15.0	10.2	0.39
			No. of Samples	2		2	2	2		2	2	2

Table SM-6 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – ST. MARYS RIVER – (continued)

Sampling Point	Mileage Index No	Feet from U.S. Shore		Coliforms M.P.N. per 100 ml.	Phenols ppb	Chlorides ppm	pH	Alkalinity ppm	Turbidity ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm
Point Iroquois, Mich. across to Gros Cap, Ont. (at Head of St. Marys River near Whitefish Bay) (Cont'd.)	SMR-35.5	19,000	Average	(Median) <1.8	0	3.0	7.8	43	0.6	11.3	10.9	0.73
			Maximum	33	0	6.9	7.9	46	1.2	27.0	13.3	2.85
			Minimum	<1.8	0	2.1	7.6	40	0.3	5.0	9.8	0.20
			No. of Samples	14	4	9	9	8	7	5	11	8
		20,000		CANADIAN SHORE								
Upper St. Marys River Brush Point Aux Pins (near USCG No. 6 Lookout Station.	SMR-5.6	500	Average	(Median) 7.8	0	4.2	7.8	45	2.6		9.5	0.5
			Maximum	350	0	6.8	8.2	48	4.0		10.0	0.8
			Minimum	< 1.8	0	1.7	7.6	44	1.1		9.2	0.2
			No. of Samples	13	2	10	11	7	9		8	8
		1000		INTERNATIONAL BOUNDARY								
		1000	Average	(Median) 3.6	1	2.0	7.6	44	3.3	15.0	10.3	0.53
			Maximum	43	5	2.3	7.8	46	5.0	18.5	11.9	1.3
			Minimum	3.6	0	1.7	7.4	36	2.3	10.0	9.3	0.21
			No. of Samples	15	4	14	13	14	7	14	14	14
		1300	Average	(Median) 2	0	4.0	7.8	45	0.78	17.5	9.8	0.58
			Maximum	350	2	7.0	8.0	48	1.2	18.5	10.2	1.67
			Minimum	<1.8	0	2.1	7.6	42	0.4	16.0	9.5	0.2
			No of Samples	23	8	14	16	13	10	5	13	13
		1600	Average	(Median) 3.6	3	2.1	7.6	44	3.7	13.6	10.8	0.81
			Maximum	75	5	2.5	7.8	48	10.0	18.0	13.1	2.40
			Minimum	< 2.3	0	1.6	7.3	36	2.2	8.0	9.8	0.80
			No of Samples	15	5	16	15	16	9	16	16	16
		1900	Average	(Median) 6.8	1	3.3	7.8	43	0.8	13.0	10.8	0.84
			Maximum	170	2	6.9	8.4	48	1.3	17.5	13.4	3.00
			Minimum	< 1.8	0	0.5	7.6	40	0.5	5.0	9.0	0.20
			No. of Samples	23	7	21	22	19	16	11	19	18
		2200	Average	(Median) 3.6	2	2.0	7.6	44	3.3	13.5	10.8	0.66
			Maximum	43	7	2.3	7.8	46	6.1	17.5	13.0	1.80
			Minimum	< 1.8	0	1.8	7.3	38	2.3	7.0	10.0	0.38
			No of Samples	21	9	14	13	14	8	14	14	14
		2500		CANADIAN SHORE								
At Sault Ste. Marie, Mich., Water Intake near USCG Dispatch Station.	SMR-3.2	1500	Average	(Median) <3.6	3	1.2	7.5	44	3.3	11	11.0	0.6
			Maximum	9.1	15	2.8	7.7	46	8	15	12.6	1.6
			Minimum	3.0	0	1.2	7.3	36	1.0	5.0	9.9	0.31
			No. of Samples	16	12	16	14	16	16	16	15	15
Upstream from No. 1 Tannery Sewer Outlet.	SMR-2.32	100	Average	(Median) 23	1	2.9	7.7	46	3.0	14.0	10.5	0.60
			Maximum	1,100	5	7.0	7.9	50	4.0	19.0	11.1	14.0
			Minimum	< 3.6	1	1.6	7.5	44	2.0	11.0	9.5	0.35
			No. of Samples	9	5	10	10	10	10	10	10	10

Table SM-6 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – ST. MARYS RIVER – (continued)

Sampling Point	Mileage Index No.	Feet from U.S. Shore		Coliforms M.P.N. per 100 ml.	Phenols ppb	Chlorides ppm	pH	Alkalinity ppm	Turbidity ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm
At No. 1 Tannery	SMR-2.3	100	Average	(Median) 430	5	16	8.4	50	5.7	14.0	10.1	3.05
Sewer Outlet.			Maximum	2,400	40	66	9.4	58	25.0	18.0	10.9	16.5
			Minimum	3.6	0	1.8	7.7	44	1.9	11.0	6.9	0.50
			No. of Samples	11	8	13	12	13	13	13	12	12
		200	Average	(Median) 23	1	4.4	7.7	45	2.5	12.0	10.9	0.79
			Maximum	43	1	7.9	7.9	46	3.2	13.0	11.0	1.45
			Minimum	< 3.6	0	1.8	7.6	44	1.8	12.0	10.9	0.31
			No. of Samples	5	2	5	5	5	5	5	5	5
At No. 2 Tannery	SMR-2.24	100	Average	(Median) 460	43	34	8.5	55	25	15.5	8.4	25.4
Outfall (300 feet			Maximum	11,000	330	160	>9.6	85	68	20.0	10.7	20.5
downstream from #1			Minimum	< 3.6	0	2.9	7.5	44	3.7	11.0	3.0	1.75
Outfall.			No. of Samples	11	9	11	12	11	13	12	12	12
		200	Average	(Median) 9.1	2	16	8.2	48	4.8	13.0	10.6	2.11
			Maximum	240	7	38	9.1	60	11.0	15.0	10.9	4.8
			Minimum	< 3.6	0	2.8	7.7	44	1.6	12.0	9.5	0.4
			No. of Samples	7	4	7	6	7	7	7	7	7
		400	Average	(Median) 9.1	0	3.7	7.7	45	2.8	12.0	10.9	0.75
			Maximum	< 36	0	6.0	7.8	47	3.5	12.5	11.0	1.09
			Minimum	< 3.6	0	1.8	7.5	44	1.7	12.0	10.8	0.45
			No. of Samples	6	2	5	5	5	5	5	5	5
Below Tannery Out-	SMR-2.1	100	Average	(Median) 330	25	59	8.4	79	15.0	13.0	9.5	9.8
lets.			Maximum	4,600	80	250	> 9.6	100	40.0	15.0	10.7	37.7
			Minimum	23	0	1.7	7.6	44	2.0	12.0	6.5	0.6
			No. of Samples	6	4	7	6	7	7	7	6	6
		200	Average	(Median) 21	1	14	8.1	48	5.2	13.0	10.4	2.62
			Maximum	39	1	37	9.5	62	10	14.0	10.8	6.5
			Minimum	3.0	0	1.5	7.7	44	1.6	12.0	9.3	0.4
			No. of Samples	6	3	6	5	6	6	6	6	6
	SMR-2.0	100	Average	(Median) 430	15	38	8.5	54	15.6	13.0	9.4	8.6
			Maximum	2,400	40	85	9.5	66	42.0	15.0	10.6	38.2
			Minimum	23	0	3.0	7.7	47	1.6	11.5	7.2	0.8
			No. of Samples	6	4	7	6	7	7	7	6	6
		200	Average	(Median) 25	1	19.7	8.3	49	4.9	13.5	10.5	2.44
			Maximum	390	1	48	8.7	55	8.0	14.0	10.9	7.50
			Minimum	3.0	0	1.6	7.8	43	2.2	12.0	10.9	0.6
			No. of Samples	6	3	6	5	6	6	6	6	6

Table SM-6 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – ST. MARYS RIVER – (continued)

Sampling Point	Mileage Index, Mi.	Feet from U.S. Shore		Coliforms M.P.N. per 100 ml.	Phenols ppb	Chlorides ppm	pH	Alkalinity ppm	Turbidity ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm
Below Tannery Out-	SMR-1.9	100	Average	(Median) 330	49	34	8.3	51	6.5	20.5	9.7	4.3
fall across to			Maximum	4,600	300	75	8.8	62	7	24.0	10.4	7.35
E.P. Coal Dock.			Minimum	25	0	1.8	8.0	45	1.5	21.	8.7	[illegible]
			No. of Samples	6	4	7	5	7	7	7	6	[illegible]
		200	Average	(Median) 93	28	24	8.3	53	5.1	20.5	9.8	4.39
			Maximum	2,400	80	37	9.3	57	8.0	24.0	10.8	11.6
			Minimum	9.1	5	1.7	7.9	48	1.5	11.5	7.8	0.8
			No. of Samples	6	3	6	5	6	5	6	6	6
		500	Average	(Median) 370	1	9.5	8.0	47	3.6	22.5	10.5	1.54
			Maximum	930	1	18	8.4	51	6.8	24.0	11.0	2.65
			Minimum	< 3.6	0	1.9	7.8	45	1.6	11.5	9.8	0.5
			No. of Samples	6	3	6	5	6	6	6	6	6
Northwestern Coal Co.	SMR-1.8	200	Average	(Median) 3.6	1	2.4	7.6	44	4.0	12.5	10.6	0.72
Dock across to Old			Maximum	150	5	5.3	7.8	8	10.2	27.5	12.7	1.31
Vessel Point, Canada			Minimum	< 2.3	0	1.5	7.5	38	2.0	8.0	9.7	0.35
(below Tannery).			No. of Samples	19	7	15	15	15	11	19	14	14
		300	Average	(Median) 3.6	1	2.1	7.6	45	3.8	13.0	10.6	0.61
			Maximum	75	3	2.7	7.8	46	7.4	16.5	12.3	1.0
			Minimum	< 3.6	0	1.7	7.4	44	2.6	9.0	9.9	0.32
			No. of Samples	17	5	10	11	10	6	17	12	12
		500	Average	(Median) 9.1		2.2	7.6	45		16.5	10.0	0.57
			Maximum	14		2.5	7.6	46		17.0	10.2	0.74
			Minimum	3.6		2.0	7.6	44		15.5	9.9	0.48
			No. of Samples	4		4	4	4		4	4	4
		800	Average	(Median) 3.6	43	2.1	7.5	44	5.9	13.5	10.7	0.61
			Maximum	23	50	3.0	7.6	45	11.5	11.0	12.6	1.2
			Minimum	< 3.6	0	1.2	7.4	36	2.6	8.0	9.9	0.21
			No. of Samples	13	4	6	9	6	3	13	10	10
		1200	Average	(Median) 5.4	2	2.0	7.6	45	3.6	13.5	10.5	0.60
			Maximum	11	7	2.4	7.8	46	8.2	17.0	12.6	1.10
			Minimum	< 2.3	0	1.7	7.4	36	2.1	8.0	10.1	0.36
			No. of Samples	26	4	10	10	10	5	26	9	9
		1600	Average	(Median) 9.1		2.2	7.6	45		16.0	10.1	0.64
			Maximum	23		2.4	7.6	45		17.0	10.2	0.77
			Minimum	< 2.3		2.0	7.6	44		15.5	10.1	0.55
			No. of Samples	4		4	4	4		4	4	4
		1800		INTERNATIONAL BOUNDARY								

Table SM-6 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – ST. MARYS RIVER – (continued)

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Sampling Point	Mileage Index No	Feet from U.S. Shore		Coliforms M.P.N. per 100 ml.	Phenols ppb	Chlorides ppm	pH	Alkalinity ppm	Turbidity ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm
Northwestern Coal	SMR-1.6	2000	Average	(Median) 3.6	1	2.3	7.5	44	3.7	13.0	[illegible]	0.60
Co. Dock across to			Maximum	14	5	2.6	7.6	46	6.3	27.0	[illegible]	
Old Vessel Point,			Minimum	< 2.3	0	1.7	7.3	35	2.0	7.0		
Canada (below			No. of Samples	15	6	11	11	10	5	15	10	[illegible]
Tannery) (Cont'd).												
		2400	Average	(Median) 5.4		2.2	7.6	44		16.0	10.1	0.60
			Maximum	14		2.7	7.6	45		27.0	10.2	0.85
			Minimum	2.3		2.0	7.6	43		15.0	10.1	0.34
			No. of Samples	4		4	4	4		4	4	4
		3000	Average	(Median) 3.6	0.4	2.1	7.5	43	5.6	13.0	10.8	0.45
			Maximum	14	1	2.8	7.6	45	7.0	27.0	13.1	2.3
			Minimum	< 3.6	0	1.1	7.4	37	4.2	7.0	10.0	0.30
			No. of Samples	15	5	7	9	7	2	15	10	10
		3600	Average	(Median) 3.6	1	2.0	7.5	44	3.1	13.0	10.9	0.62
			Maximum	9.1	3	2.6	7.6	46	7.0	27.0	12.9	1.1
			Minimum	< 2.3	0	1.2	7.3	36	2.0	7.0	10.1	0.30
			No of Samples	14	6	10	10	10	7	14	19	9
		4700		CANADIAN SHORE								
Upper St. Marys	SMR-1.0	1200	Average	(Median) 37	2	5.3	7.9	43	1.1	9.5	10.8	1.07
River immediately			Maximum	350	15	13.6	8.4	48	3.2	13.5	13.4	2.60
above Locks to Falls.			Minimum	< 1.8	0	2.0	7.6	40	0.5	7.0	9.2	0.30
			No. of Samples	20	11	16	17	14	16	6	14	13
		2600	Average	(Median) 2	1	3.7	7.8	43	9.3	9.5	11.3	7.8
			Maximum	350	4	7.0	8.4	46	2.3	13.5	13.3	2.40
			Minimum	< 1.8	0	2.5	7.5	40	0.5	6.0	9.4	0
			No. of Samples	20	11	12	13	12	13	6	10	11
		3800	Average	(Median) 6.1	0	4.6	7.9	45	7.6		9.6	0.4
			Maximum	270	2	7.8	8.0	48	1.4		10.2	0.8
			Minimum	< 1.8	0	2.4	7.7	43	0.3		[illegible]	0.0
			No of Samples	20	11	10	11	8	10		7	8
		5000	Average	(Median) < 1.8	1	2.7	7.9	41	0.8	9.3	[illegible]	1.02
			Maximum	2	2	3.0	8.5	41	1.0	13.5	[illegible]	2.35
			Minimum	1.8	0	2.5	7.8	40	0.5	6.0	11.3	0.10
			No. of Samples	6	6	6	6	6	6	6	6	6
		5500		INTERNATIONAL BOUNDARY								
		6000	Average	(Median) <1.8	1							
			Maximum	<1.8	2							
			Minimum	<1.8	0							
			No. of Samples	6	5							

Table SM-6 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – ST. MARYS RIVER – (continued)

Sampling Point	Mileage Index No.	Feet from U.S. Shore		Coliforms M.P.N. per 100 ml.	Phenols ppb	Chlorides ppm	pH	Alkalinity ppm	Turbidity ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm
Upper St. Marys	SMU-1.0	7200	Average	(Median) 7.8	0	3.9	7.9	42	0.7	9.5	11.4	0.84
River immediately			Maximum	140	2	6.9	8.5	48	1.2	13.5	13.2	2.35
above Locks to			Minimum	< 1.8	0	2.5	7.8	40	0.3	7.0	9.4	[illegible]
Falls (Cont'd).			No. of Samples	20	20	20	11	9	11	6	10	10
		7700	Average	(Median) 94	1	3.8	7.9	44	1.6	10.0	10.8	0.78
			Maximum	920	4	7.8	8.5	48	4.0	13.5	13.2	2.05
			Minimum	< 1.8	0	2.5	7.6	40	0.5	7.0	9.2	0.05
			No. of Samples	20	11	16	27	22	16	6	14	14
		7700		CANADIAN SHORE (AT ALGOMA STEEL MILL BOAT SLIP)								
East of Canadian Lock and across	SMU-0.5	0 300	Average	(Median) CANADIAN LOCK APPROACH WALL 3.6	0	2.0	7.5	44	3.0	12.5	11.1	0.71
Algoma Steel Co.			Maximum	230	2.	2.4	7.7	46	8.0	16.5	12.9	1.4
Boat Slip.			Minimum	< 3.6	0	1.2	7.4	37	1.5	6.0	9.9	0.39
			No. of Samples	15	8	15	13	15	12	15	15	15
		600	Average	(Median) 23	4	1.9	7.5	44	3.6	12.5	11.0	0.79
			Maximum	93	25	2.4	7.7	46	8.5	17.0	13.0	2.0
			Minimum	< 2.3	0	1.4	7.3	37	2.2	6.0	10.0	0.43
			No. of Samples	15	7	14	12	14	10	15	15	15
		1500	Average	(Median) 230	16	2.0	7.5	46	5.8	13.5	10.4	1.04
			Maximum	4,600	50	2.5	7.7	51	18	18.0	12.4	2.2
			Minimum	23	0	1.6	7.3	37	1.8	6.0	9.5	0.50
			No. of Samples	15	7	15	12	15	11	15	14	14
		1800	Average	(Median) 9.1	5	2.0	7.6	45	3.8	12.5	10.9	0.88
			Maximum	240	20	2.4	7.7	48	7.0	18.0	12.8	2.1
			Minimum	3.6	0	1.2	7.4	38	2.0	7.0	9.6	0.41
			No. of Samples	15	8	15	13	15	12	15	15	15
		2200		CANADIAN SHORE								
Upper St. Marys	SMU-PC 0.1	100	Average	(Median) 9.1		2.2	7.7	46	4	16.5	10.4	0.97
River, Power Canal			Maximum	23		2.4	7.8	47	5	18.0	10.6	1.2
at Fort St. Bridge.			Minimum	3.6		2.0	7.6	45	3	16.0	10.2	0.28
			No. of Samples	5		5	4	5	5	5	5	5
Lower St. Marys	SMD-0.8	100	Average	(Median) 4,600	1	2.9	7.7	45	2.1	13.0	10.6	0.76
below Soo Locks.			Maximum	92,000	12	12	8.4	48	4.2	18.5	13.0	1.80
			Minimum	140	0	1.6	7.3	40	0.5	6.0	9.2	0.0
			No. of Samples	62	39	52	52	51	54	42	48	50
		960	Average	(Median) 2,400	1	4.0	7.8	44	1.5	14.0	10.5	0.62
			Maximum	17,000	5	7.6	8.5	48	3	18.5	13.0	1.45
			Minimum	20	0	2.0	7.3	40	0.7	5	9.1	0
			No. of Samples	59	36	27	23	26	20	35	34	34

Table SM-6 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – ST. MARYS RIVER – (continued)

Sampling Point	Mileage Index No.	Feet from U.S. Shore		Coliforms M.P.N. per 100 ml.	Phenols ppb	Chlorides ppm	pH	Alkalinity ppm	Turbidity ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm
Lower St. Marys	SMD-0.8	1800	Average	(Median) 35	1	2.7	7.7	44	1.9	13.0	10.5	0.58
River below Soo			Maximum	27,000	28	7.7	8.5	50	4.0	18.5	13.0	1.8
Locks (Cont'd)			Minimum	<1.8	0	1.4	7.3	40	0.6	6.0	9.2	0
			No. of Samples	61	45	50	50	50	50	42	49	52
		2700		INTERNATIONAL BOUNDARY								
		2000	Average	(Median) 23	2	3.5	7.7	44	1.5	14.0	10.5	0.67
			Maximum	5,400	14	8.5	8.5	48	3	18.5	13.2	2.25
			Minimum	<1.8	0	2.0	7.4	40	0.6	6	9.0	0.26
			No. of Samples	61	49	39	26	37	23	34	35	36
		2300	Average	(Median) 230	9	1.9	7.5	46	3.0	14.5	10.4	0.85
			Maximum	24,000	40	3.0	7.8	48	4.2	18.5	12.5	2.65
			Minimum	9.1	0	1.5	7.4	42	2.4	7.0	8.3	0.28
			No. of Samples	30	29	13	15	13	13	30	29	29
		2700	Average	(Median) 5,400	27	2.5	7.6	44	2.3	13.5	10.3	2.37
			Maximum	110,000	80	6.8	8.5	48	4.0	18.5	12.9	3.90
			Minimum	430	0	1.2	7.2	40	0.8	6.0	9.0	1.30
			No. of Samples	64	54	52	52	50	55	42	50	52
		2900		CANADIAN SHORE								
Lower St. Marys	SMD-PC 1.5	100	Average	(Median) 43		2.2	7.7	47	4	16.5	10.3	0.66
River, Power Canal			Maximum	150		2.3	7.8	49	5	18.0	10.6	1.8
at Portage Street			Minimum	7.3		2.0	7.7	45	3	15.5	10.1	0.22
Bridge.			No. of Samples	5		5	4	5	5	5	5	5
Lower St. Marys	SMD-1.0	600	Average	(Median) 460	1	1.8	7.5	45	1.7	13.5	9.9	0.34
River at Power			Maximum	1,500	6	1.8	7.7	46	3.0	15.5	10.0	0.39
House.			Minimum	43	0	1.7	7.3	44	1.1	10.0	9.8	0.31
			No. of Samples	5	5	4	5	5	4	5	3	3
		400	Average	(Median) 93	0	1.7	7.5	44	1.6	13.5	9.9	0.49
			Maximum	240	1	2.0	7.7	45	2.5	15.5	9.9	0.57
			Minimum	23	0	1.6	7.3	44	1.0	10.0	9.9	0.40
			No. of Samples	5	5	5	5	5	5	5	3	3
		200	Average	(Median) 23	0	1.8	7.6	45	1.5	13.5	10.0	0.49
			Maximum	43	1	1.9	7.7	46	2.3	15.5	10.0	0.56
			Minimum	7.3	0	1.7	7.4	44	1.0	10.0	9.9	0.43
			No. of Samples	5	5	4	5	5	4	5	3	3
Lower St. Marys	SMD-1.2	200	Average	(Median) 43	2	1.7	7.5	45	1.8	13.0	9.9	0.39
River below Power			Maximum	43	20	1.9	7.7	45	3.8	15.5	10.0	0.43
House.			Minimum	14	0	1.6	7.4	43	0.8	11.0	9.9	0.36
			No. of Samples	5	5	5	5	5	5	5	3	3

Table SM-6 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – ST. MARYS RIVER – (continued)

Sampling Point	Mileage Index No.	Feet from U.S. Shore		Coliforms M.P.N. per 100 ml	Phenols ppb	Chlorides ppm	pH	Alkalinity ppm	Turbidity ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm
Lower St. Marys	SMR-1.2	400	Average	(Median) 23	3	1.6	7.5	44	1.9	13.5	9.9	0.42
River below Power			Maximum	4,600	20	1.8	7.7	45	2.5	15.5	10.0	0.47
House. (Cont'd).			Minimum	23	0	1.6	7.4	44	1.1	11.0	9.8	0.40
			No. of Samples	5	5	4	5	4	4	5	3	3
		600	Average	(Median) 23	2	1.7	7.5	44	1.9	13.5	9.9	0.43
			Maximum	430	20	1.8	7.7	45	2.6	15.5	10.0	0.47
			Minimum	3.9	0	1.5	7.3	43	0.9	11.0	9.8	0.39
			No. of Samples	5	5	3	4	3	3	5	3	3
		900	Average	(Median) 23	0	1.8	7.5	45	1.5	13.5	9.9	0.34
			Maximum	93	1	1.9	7.7	45	2.5	15.5	10.0	0.44
			Minimum	9.1	0	1.7	7.4	44	0.8	11.0	9.8	0.26
			No. of Samples	5	5	5	5	5	5	5	3	3
Lower St. Marys	SMR-1.0	100	Average	(Median) 930	1	2.7	7.7	45	2.2	13.2	10.7	0.97
River below Sault			Maximum	46,000	19	7.0	8.4	48	18.5	18.3	13.0	1.80
Ste. Marie			Minimum	22	0	1.2	7.3	40	0.2	6.0	9.2	0
			No. of Samples	46	41	53	52	50	56	45	50	54
		500	Average	(Median) 370	2	2.4	7.7	42	1.2	13.5	10.6	0.50
			Maximum	4,600	15	2.7	8.4	48	3	18.5	13.2	1.05
			Minimum	3.6	0	2.0	7.3	40	0.4	6.0	9.0	0.05
			No. of Samples	44	27	8	26	8	16	38	31	30
		1500	Average	(Median) 93	1	4.2	7.7	45	1.6	14.5	10.1	0.59
			Maximum	1,600	7	30	8.2	47	3.8	18.5	12.4	1.40
			Minimum	3.0	0	1.2	7.4	43	0.5	7.0	9.2	0.29
			No. of Samples	55	28	15	27	13	16	35	34	36
		2100		INTERNATIONAL BOUNDARY								
		2100	Average	(Median) 43	1	3.0	7.7	45	1.7	13.5	10.5	0.57
			Maximum	1,600	8	11.0	8.5	49	3.3	18.5	13.1	1.60
			Minimum	< 1.8	0	1.5	7.3	41	0.4	6.0	9.4	0
			No. of Samples	65	47	49	48	46	50	39	49	51
		3000	Average	(Median) 240	4.1	4.6	7.7	46	1.5	14.5	10.1	0.84
			Maximum	> 16,000	25	10.3	7.9	48	3	18.5	12.5	2.90
			Minimum	7.3	0	1.3	7.4	44	0.7	7.0	8.9	0.30
			No. of Samples	55	43	14	16	13	16	33	34	36
		3500	Average	(Median) 2,400	11	2.3	7.6	43	1.7	13.2	10.7	1.11
			Maximum	24,000	30	3.6	8.0	48	3.3	19.0	13.1	2.82
			Minimum	49	0	1.5	7.3	40	0.7	6.0	9.1	0.51
			No. of Samples	44	42	27	22	27	18	44	44	43

Table SM-6 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – ST. MARYS RIVER – (continued)

Sampling Point	Mileage Index No	Feet from U.S. Shore		Coliforms M.P.N. per 100 ml.	Phenols ppb	Chlorides ppm	pH	Alkalinity ppm	Turbidity ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm
Lower St. Marys	SMD-2.0	4000	Average	(Median) 4,600	18	2.5	7.6	44	2.1	13.0	10.3	1.66
River below Sault			Maximum	92,000	45	7.0	8.4	48	3.8	19.5	12.8	3.22
Ste. Marie. (Cont'd).			Minimum	230	0	1.0	7.0	39	0.7	6.0	8.5	0.50
			No. of Samples	66	55	52	52	49	56	44	49	54
		4300		CANADIAN SHORE								
Lower St. Marys	SMD-[illegible].1 W	0		UNITED STATES SHORE								
River, Mission Point		100	Average	(Median) 220	2	2.2	7.7	43	1.7	10.0	12.3	0.86
to Sugar Island at			Maximum	1,600	10	2.8	8.4	49	3.5	12.5	13.2	1.65
Ferry Crossing.			Minimum	70	0	1.6	6.9	41	0.5	6.0	10.9	0.50
			No. of Samples	19	16	13	15	13	15	15	10	9
		500	Average	(Median) 43	1	2.3	7.7	43	1.6	9.7	12.1	0.80
			Maximum	540	7	3.2	8.5	48	3.4	12.5	13.3	1.35
			Minimum	4.5	0	1.6	7.4	40	0.4	6.0	10.8	0.20
			No. of Samples	29	27	25	28	25	29	29	29	27
		900	Average	(Median) 93	0.5	2.3	7.7	42	1.7	9.9	12.4	0.84
			Maximum	540	2	3.0	8.5	46	3.7	12.5	13.1	1.35
			Minimum	23	0	1.6	7.0	40	0.6	6.0	11.2	0.30
			No. of Samples	19	17	13	15	13	15	15	10	9
		950		WEST SHORE OF SUGAR ISLAND, UNITED STATES								
Lower St. Marys	SMD-5.3 W	0		UNITED STATES SHORE								
River, West Sugar		100	Average	(Median) 300	2	1.9	7.8	47	2	17.0	9.8	0.37
Island Channel at			Maximum	2,400	6	2.1	7.8	47	3	18.5	11.4	0.57
Frechette Point.			Minimum	93	0	1.8	7.7	47	2	9.0	9.3	0.15
			No. of Samples	12	9	2	2	2	2	12	12	12
		500	Average	(Median) 93	1	3.2	7.8	46	1.9	17.0	9.8	0.43
			Maximum	540	12	7.6	8.2	48	3	18.5	11.3	0.80
			Minimum	23	0	1.8	7.5	44	0.8	9.0	9.2	0
			No. of Samples	26	19	19	19	20	19	12	20	21
		900	Average	(Median) 93	2	2.1	7.5	45	2	17.0	9.9	0.46
			Maximum	> 2,400	15	2.3	7.7	46	3	18.5	11.4	0.68
			Minimum	23	0	1.9	7.3	44	2	9.0	9.6	0.20
			No. of Samples	12	9	2	2	2	2	12	12	12
		1000		WEST SHORE OF SUGAR ISLAND, UNITED STATES								
Lower St. Marys	SMD-10.1 W	0		UNITED STATES SHORE								
River, E. Neebish Channel, at Lights		150	Average	(Median) 150	1	2.6	7.7	45	3.3	13.5	10.4	0.54
19 and 20.			Maximum	1,600	15	7.5	7.9	48	8.0	20.0	12.5	1.20
			Minimum	< 3.6	0	1.7	7.4	36	1.1	7.0	8.9	0
			No. of Samples	28	23	26	26	26	24	19	25	27
		300		WEST SHORE OF NEEBISH ISLAND, UNITED STATES								
Lower St. Marys	SMD-16.0 [illegible]	0		NORTH SHORE, NEEBISH ISLAND, UNITED STATES								
River, Middle Neebish Channel at		600	Average	(Median) 79	1	2.4	7.7	43	1.8	10.0	12.0	0.91
Light No. 40.			Maximum	170	3	3.3	8.5	48	2.4	13	12.9	2.05
			Minimum	7.8	0	1.4	7.5	40	0.8	7	10.4	0.20
			No. of Samples	15	15	13	14	13	15	15	15	15
		1400		SOUTH SHORE OF SUGAR ISLAND, UNITED STATES								

Table SM-6 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – ST. MARYS RIVER – (continued)

Sampling Point	Mileage Index No.	Feet from U.S. Shore		Coliforms M.P.N. per 100 ml.	Phenols ppb	Chlorides ppm	pH	Alkalinity ppm	Turbidity ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm
		0		(Median) EAST SHORE OF [illegible] ISLAND, UNITED STATES								
Lower St. Marys	SMR-22.6 E	100	Average	43	0	1.7	7.7	47	2.3	18.0	9.9	0.32
River, Middle			Maximum	150	1	1.9	7.8	47	2.6	19.5	12.4	1.00
Neebish Channel ab			Minimum	23	0	1.4	7.5	46	2.0	8.0	9.1	0.32
Johnson Point.			No. of Samples	7	6	2	2	2	2	7	7	5
		500	Average	(Median) 86	1	3.6	7.8	45	2.6	17.5	9.7	0.50
			Maximum	> 1,600	2	7.0	7.9	46	4.0	20.0	12.5	1.20
			Minimum	43	0	1.4	7.5	44	1.1	8	9.2	0.20
			No. of Samples	16	13	12	13	12	13	7	13	14
		900		INTERNATIONAL BOUNDARY								
		900	Average	(Median) 43	1	2.0	7.6	47	2.2	17.5	10.0	0.61
			Maximum	240	3	2.1	7.7	47	2.4	20.0	12.5	1.7
			Minimum	23	0	1.8	7.5	46	2.0	8.0	9.4	0.22
			No. of Samples	7	7	2	2	2	2	7	7	7
		0		(Median) NORTH SHORE OF [illegible] [illegible] ISLAND, CANADA								
Lower St. Marys	SMR-4.2 E	200	Average	280	3	2.3	7.7	43	1.6	12.5	11.5	0.61
River, Lake George			Maximum	4,600	35	3.0	8.5	47	3	18.5	13.1	2.35
Channel, below			Minimum	14	0	1.2	7.3	40	0.6	6.0	9.5	0.05
Black Point.			No. of Samples	41	37	26	30	26	31	43	42	41
		500	Average	930	4	2.7	7.7	44	1.4	12.0	10.9	0.93
			Maximum	11,000	20	7.0	8.5	48	3.9	18.5	12.9	2.65
			Minimum	23	0	1.2	7.3	40	0.4	6.0	9.0	0.00
			No. of Samples	63	51	47	51	48	54	42	52	51
		800	Average	(Median) 3,500	11	2.4	7.6	43	1.7	12.0	11.0	1.44
			Maximum	24,000	45	3.0	8.5	47	3.2	19.0	12.8	2.60
			Minimum	93	0	1.7	7.1	40	0.8	6.0	8.8	0.43
			No. of Samples	42	40	26	31	26	30	41	41	4
		900		CANADIAN SHORE								
		0		(Median) NORTH SHORE OF SUGAR ISLAND, UNITED STATES								
Lower St. Marys	SMR-6.5 E	100	Average	930	1	2.7	7.7	41	1.2	10.5	11.9	1.19
River, Lake George			Maximum	1,600	7	3.0	8.4	44	2.5	13.5	12.7	2.50
Channel, Palmers			Minimum	95	0	1.6	7.4	40	0.7	8.0	10.6	0.44
Point to Belle			No. of Samples	14	13	8	12	9	10	12	10	10
Point.												
		500	Average	(Median) 1,700	4	2.2	7.6	43	1.3	11.0	11.6	1.06
			Maximum	3,500	18	3.0	8.4	47	2.3	13.0	12.5	2.35
			Minimum	140	0	1.2	7.4	40	0.7	7.0	10.2	0.58
			No. of Samples	16	16	13	15	13	15	14	15	15
		600		INTERNATIONAL BOUNDARY								
		800	Average	(Median) 16,000	6	2.6	7.6	42	1.3	11.0	11.6	1.23
			Maximum	11,000	35	3.0	8.4	46	2.5	13.5	12.6	2.45
			Minimum	230	0	1.6	7.4	40	0.8	7.5	10.4	0.44
			No. of Samples	14	13	9	12	10	11	12	11	11
		1100		CANADIAN SHORE								

Table SM-6 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – ST. MARYS RIVER – (continued)

Sampling Point	Mileage Index No.	Feet from U.S. Shore		Coliforms M.P.N. per 100 ml.	Phenols ppb	Chlorides ppm	pH	Alkalinity ppm	Turbidity ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm
		0		EAST SHORE OF SUGAR ISLAND, UNITED STATES								
Lower St. Marys	SM-14.2	200	Average	(Median) 930	4	2.8	7.7	42	1.0	10.5	11.6	.12
River, Lake George			Maximum	2,400	30	3.0	8.4	42	1.5	13.5	[illegible]	[illegible]
Channel, Churchville			Minimum	240	0	2.5	7.5	40	0.7	8.0	10.7	
Point to Sand Island			No. of Samples	13	13	6	9	6	8	11	10	9
		600	Average	(Median) 930	6	2.3	7.6	42	1.3	10.5	11.6	1.09
			Maximum	3,500	45	3.3	8.4	44	2.4	13.0	12.5	1.55
			Minimum	240	0	2.2	7.4	40	0.8	7.5	10.2	0.64
			No. of Samples	15	15	13	15	13	15	15	15	15
		880		INTERNATIONAL BOUNDARY								
		1000	Average	(Median) 930	3	3.0	7.7	40	1.1	9.0	11.7	1.12
			Maximum	3,500	16	3.3	8.4	41	1.5	13.0	12.1	1.85
			Minimum	270	0	2.8	7.5	39	0.8	7.5	10.3	0.65
			No. of Samples	13	13	7	9	7	9	11	10	10
		1300		CANADIAN SHORE								
		0		EAST SHORE OF SUGAR ISLAND, UNITED STATES								
Lower St. Marys	SM-15.0	1000	Average	(Median) 350	3	1.6	7.5	44	1.9	11.0	11.0	1.0
River, at Head of			Maximum	1,500	16	2.0	7.5	45	2.3	12.0	11.5	1.3
Lake George, Sugar			Minimum	49	0	1.4	7.4	42	1.4	10.0	10.2	0.7
Island to Sand			No. of Samples	13	12	4	4	4	4	4	3	3
Island.												
		4000	Average	(Median) 230	3	1.8	7.4	44	1.5	10.0	10.4	0.62
			Maximum	4,600	16	1.8	7.4	44	1.5	10.0	10.5	0.75
			Minimum	46	0	1.8	7.4	44	1.5	10.0	10.2	0.49
			No. of Samples	13	13	1	1	1	1	2	2	2
		7000	Average	(Median) 540	10	2.4	7.6	42	1.4	11	11.5	0.95
			Maximum	4,600	90	3.3	8.4	45	3.8	14	12.4	1.45
			Minimum	91	0	1.5	7.4	39	0.7	8	10.5	0.49
			No. of Samples	15	14	13	15	13	15	15	15	15
		7400		INTERNATIONAL BOUNDARY								
		10,000	Average	(Median) 130	4					10.8	10.1	0.80
			Maximum	1,600	16					11.5	10.1	0.80
			Minimum	13	0					10.0	10.1	0.80
			No. of Samples	13	13					2	1	1
		12,000	Average	(Median) 270	2	1.7	7.5	44	2.1	11.5	10.[illegible]	[illegible].85
			Maximum	1,600	15	2.0	7.5	44	3.0	13	11.3	1.20
			Minimum	32	0	1.5	7.4	43	1.5	10.0	10.1	0.74
			No. of Samples	13	12	4	4	4	4	4	3	3
		13,600		CANADIAN SHORE								
Lower St. Marys	SM-16.0	0		EAST SHORE, SUGAR ISLAND, UNITED STATES								
River, Lake George		1000	Average	(Median) 49	6	1.6	7.5	47	7.5	13	11.2	0.60
East-West Range at			Maximum	350	20	1.6	7.5	47	7.5	13	11.2	0.60
Bay Point.			Minimum	13	0	1.6	7.5	47	7.5	13	11.2	0.60
			No. of Samples	11	6	1	1	1	1	1	1	1

Table SM-6 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – ST. MARYS RIVER – (continued)

Sampling Point	Mileage Index No.	Feet from U.S. Shore		Coliforms M.P.N. per 100 ml.	Phenols ppb	Chlorides ppm	pH	Alkalinity ppm	Turbidity ppm	Temp °C	D.O. ppm	B.O.D. 5 day ppm
Lower St. Marys	SM-28.0 E	4000	Average	(Median) 230	1	1.8	7.5	45	2.0	10.8	10.4	0.74
River, Lake George			Maximum	1,600	10	2.0	7.5	45	2.5	11.0	10.8	0.96
[illegible] Range at			Minimum	27	0	1.6	7.4	45	1.6	10.5	10.0	0.51
Bay Point.(Back'd).			No. of Samples	13	13	2	2	2	2	2	2	2
		5350		INTERNATIONAL BOUNDARY								
		7400	Average	(Median) 230	3	2.4	7.6	41	1.9	10.5	11.5	0.91
			Maximum	930	16	3.2	8.4	44	4.7	14.0	12.2	1.95
			Minimum	46	0	1.4	7.5	39	0.7	11	10.7	0.40
			No. of Samples	13	13	11	13	11	13	13	13	13
		10,000	Average	(Median) 130	2							
			Maximum	930	12							
			Minimum	7.8	0							
			No. of Samples	11	11							
		12,000	Average	(Median) 130	1	1.4	7.5	43	3.4	12	11.2	0.80
			Maximum	4,600	10	1.4	7.5	43	3.4	12	11.2	0.80
			Minimum	9.3	0	1.4	7.5	43	3.4	12	11.2	0.80
			No. of Samples	11	11	1	1	1	1	1	1	1
		15,000		CANADIAN SHORE								
Lower St. Marys	SM-25.0 E	0		EAST SHORE OF SUGAR ISLAND, UNITED STATES								
River, South of Lake George, [illegible] to [illegible] Point.		900	Average	(Median) 23	0		7.5			10.8	9.7	0.42
			Maximum	930			7.5			11.5	9.7	0.42
			Minimum	4.5			7.5			10.0	9.7	0.42
			No. of Samples	13	11		1			2	1	1
		1100	Average	(Median) 23	2	2.3	7.7	42	3.4	13.0	10.8	0.75
			Maximum	430	26	3.2	8.4	47	8.2	15.5	11.5	1.50
			Minimum	3.6	0	1.0	7.4	39	1.5	10.0	9.6	0.50
			No. of Samples	15	15	13	15	13	15	15	15	15
		1300		INTERNATIONAL BOUNDARY								
		1700	Average	(Median) 83	1	2.9	7.7	40	2.9	13.0	10.9	0.76
			Maximum	930	5	3.2	8.4	43	4.4	15.5	11.5	1.50
			Minimum	3.6	0	2.3	7.5	39	1.5	10.0	9.9	0.50
			No. of Samples	13	11	7	10	7	9	11	10	10
		2000		CANADIAN SHORE								
		0		NORTH SHORE OF ST. JOSEPH ISLAND, CANADA								
Lower St. Marys	SM-30.0 E	400	Average	(Median) 240	2	2.1	7.6	47	2.7	19.0	9.2	0.90
River, St. Joseph			Maximum	460	3	2.2	7.7	47	3.3	21.5	10.8	3.20
Channel, Boulanger			Minimum	93	0	2.0	7.5	46	2.0	11.0	8.8	0.23
Point to [illegible]			No. of Samples	7	7	2	2	2	2	7	7	6
[illegible] Island.												
		1000	Average	(Median) 460	2	3.2	7.7	46	2.6	20.0	9.1	0.59
			Maximum	> 1,600	4	7.0	7.9	48	4	21.0	9.4	1.20
			Minimum	43	0	1.8	7.6	43	1.7	18.5	8.6	0.30
			No. of Samples	18	14	12	14	13	14	6	12	14

Table SM-6 – SUMMARY OF AVERAGE ANALYTICAL RESULTS – ST. MARYS RIVER – (continued)

Sampling Point	Mileage Index No.	Feet from U.S. Shore		Coliforms M.P.N. per 100 ml. (Median)	Phenols ppb	Chlorides ppm	pH	Alkalinity ppm	Turbidity ppm	Temp. °C	D.O. ppm	B.O.D. 5 day ppm
Lower St. Marys	[illegible]-35.6	[illegible]	Average	[illegible]	3	2.0	7.7	48	2	20.0	9.1	0.56
River, St. Joseph			Maximum	[illegible]	4	2.0	7.7	48	2	21.0	9.2	0.79
Channel, [illegible]			Minimum	[illegible]	0	2.0	7.7	48	2	18.5	9.[illegible]	[illegible]
Point to [illegible]			No. of Samples	6	6	1	1	1	1	6	6	6
[illegible] Island.		2000		[illegible] SHORE OF [illegible] ISLAND, CANADA								
(Cont'd).			Average									
			Maximum									
			Minimum									
			No. of Samples									
			Average									
			Maximum									
			Minimum									
			No. of Samples									

SUPPLEMENTARY INFORMATION ON POLLUTION EFFECTS

The effects of pollution were revealed not only by the analytical results on river water samples but also through special studies. These included the municipal water supplies and microscopic examinations of bottom deposits in the river.

Municipal Water Supplies

The source of municipal water supply for Sault Ste. Marie, Ontario, is the upper St. Marys River. The intake is located on the offshore side of the Great Lakes Power Company's headrace. The quality of this water is influenced by land drainage from a large industrial area, cooling water and some industrial waste, runoff from the unsewered community near Davignon Creek, and vessels in the approach to the Canadian lock. These sources contribute some bacterial and phenolic pollution. They have had only intermittent effect on the quality of the water but their presence does constitute a potential hazard.

A special study on the quality of the Sault Ste. Marie, Ontario, water supply was conducted from May 20 to June 19, 1948. A total of 212 hourly samples, taken between 8 A.M. and 3 P.M. for 27 days, were analyzed for coliforms and phenols. The results are summarized in table SM-7.

Table SM-7 - SPECIAL STUDY, SAULT STE. MARIE, ONTARIO, WATER SUPPLY

Percentage of samples in various groups			
Coliform Organisms (M.P.N.per 100 ml.)	%	Phenols (p.p.b.)	%
Less than 1.8	72.0	Zero phenol	81.6
2.0 to 4.5	21.6	Trace	15.5
6.8 to 33	6.4	4 to 8 p.p.b.	2.9

This study indicates that bacterial pollution at this intake was not serious. However, it does not preclude the possibility of serious pollution, from sources already enumerated, under adverse conditions.

Similarly, phenols were seldom found in higher than trace proportions, and these amounts have been effectively handled by the chlorine-ammonia treatment. The relative positions of the water intakes and industrial outfalls, which might accidentally discharge by-product coke wastes and oils to the river, present a constant threat to the water supply.

The intake of the Sault Ste. Marie, Michigan, water works is also in the upper St. Marys River, 3.2 miles upstream from the United States locks. It is situated 1,600 feet offshore, opposite Big Point, in 42 feet of water. This intake is approximately a mile above the nearest source of industrial waste, but back eddies bring it under the influence of these wastes. Treatment of the water is by free chlorination. The bacterial quality of the raw water is indicated through analyses for the year 1946. For three months of this time the raw water showed no coliforms. The highest monthly average was 5 M.P.N.

The Michigan Department of Health reports that no unusual difficulty has been encountered in furnishing a safe and palatable water to the city from this source. Unconfirmed reports have indicated that wastes from the tannery reach the intake occasionally. Instances have occurred when river traffic has been blocked, causing a heavy concentration of vessels in the vicinity of the intake. It has then been necessary for the State Health Department to request withdrawal of the ships to Whitefish Bay to protect the supply against excessive bacterial contamination.

River Bottom Deposits

In August, 1947, a special study was made of bottom deposits in the St.Marys River in the vicinity of the two cities. Ashmun Bay, on the United States side, was seriously polluted by the outfalls from the Northwestern Leather Company tannery. The water was turbid and contained numerous floating balls of hair, some of which were detected in the international channel near Sugar Island. Chrome wastes at this point colored the sand of the bay, but this waste was not noticeable in the river proper.

Thin muddy deposits, composed chiefly of fine iron ore and coal dust, were noticeable in the vicinity of the Algoma Steel Corporation's dock. Bark from log booms above the locks also littered the immediate shore and bottom.

In the lower St. Marys River a heavy gelatinous and filamentous growth was abundant below the Abitibi Pulp and Paper Company's outfalls and enmeshed numerous paper fibers. The addition of waste from the steel plant and a large proportion of the domestic sewage from Sault Ste. Marie, Ontario, causes this growth to become profuse. Iron ore solids were embedded in this mass. Farther downstream the growth consisted of a zoogleal mass containing numerous algae and protozoa. The pollution and growth are carried downstream, and the first crossing of the boundary line was noted just upstream from Brassar Post Office, on Sugar Island, 8½ miles below the locks. Farther downstream the growth gradually diminished. Near Brassar Post Office balls of hair were seen occasionally, indicating that pollution from the United States side also travels down the Lake George Channel.

CHAPTER SM-VIII

DISCUSSION OF FINDINGS AND REMEDIAL MEASURES

This report presents data on the results of the investigation of pollution in the Lake Superior-Lake Huron section of the boundary waters. The survey was prompted by a series of complaints about objectionable deposits along the Sugar Island shore line and elsewhere. Information was needed to determine the adverse effects of sewage and industrial wastes, from the two cities of Sault Ste. Marie, upon the uses of these waters. The information in this report has been obtained in accordance with the terms of reference to the Commission, to show the extent, nature, and sources of pollution, and in what localities such pollution occurs. The findings and conclusions of the Board are discussed herewith.

The area adjacent to this section of the boundary is growing in population and expanding as a tourist and recreational center. It possesses important industries and offers attractions for industrial expansion through an almost unlimited supply of water. The future development and welfare of these communities are closely related to those activities which require the maintenance of these waters free from objectionable pollution.

THE 1913 INVESTIGATION

In 1913 the total urban population on the St. Marys River was 30,500 with concentrations of 12,500 at Sault Ste. Marie, Michigan and 18,000 at Sault Ste. Marie, Ontario. These two municipalities comprised practically the whole contributing population on the St. Marys River basin. Neither municipality provided sewage treatment, and the raw wastes were discharged through numerous outlets along both shores. No reference was made to the significance of industrial wastes although such Canadian industries as paper and steel mills were in operation at that time, as well as the tannery on the United States side.

The extent of the bacterial pollution in 1913 is detailed in chapter SM-VII. Lake Superior was found to be practically pure. The discharge of sewage from vessels was stated to pollute the waters seriously in the lanes of vessel traffic. Below the two municipalities the pollution was shown to increase to 291 B. coli per 100 c.c., and it was stated this serious condition continued, although in a less pronounced degree, down the river to Neebish Island.

CHANGES IN PERIOD 1913-1946

In the interim between the 1913 and 1946 investigations there has been a substantial increase in population which now totals 47,000,with a concentration of 17,300 on the United States side and 29,700 on the Canadian side. While there has been some increase in rural population, especially on the outskirts of the main cities, these figures are indicative of the increase in sewage pollution imposed upon the river. Some industrial expansion has taken place, but not to as marked an extent as in the Lake Huron - Lake Erie section. This growth has been largely in industries existing at that time.

In the public water supplies of this section no major change in treatment facilities has been made since 1913. Filtration has not been adopted, but improvements in chlorination practice have been introduced. Taste control has been put into practice on the Canadian side by the use of the chlorine-ammonia process.

No facilities have been provided for the treatment of sewage from the two principal centers of population, except for some very small areas. Some changes have been made in the outlets.

EXTENT AND EFFECTS OF POLLUTION IN 1946-1948

In preceding chapters, information has been presented to show the sources, character, and extent of the pollution that exists today. Laboratory results indicate that both domestic and industrial wastes are responsible for this pollution. The findings of the Board are discussed herewith in connection with the questions contained in the terms of reference.

Transboundary Crossing

The transfer of pollution from one side of the boundary to the other has been demonstrated in several instances. The natural conditions in this section are conducive to ready diffusion of waters across the stream from shore to shore. Such conditions include strong currents, sharp changes in direction, sudden narrowing of channels, falls and rapids, and islands or other physical barriers.

The pollution from both cities is discharged at the shores and would have a tendency to follow in these paths, but the force exerted through the diversion of water for power purposes on both sides induces more rapid diffusion across the river. This is supported by the presence of tannery wastes in the Lake George Channel, after passing through the Michigan Northern Power Company's canal, and the presence of paper fibre on the United States side of the Lake George Channel. The fact that the figures for coliform values and phenols in the Lake George Channel show an even distribution across the channel indicates a transfer of pollution from each side of the boundary to the other. Since pollution from each source tends to lose its identity, it is difficult to establish the magnitude of this transfer. The information available shows that most of the transboundary crossing takes place in the Lake George Channel.

Injury to Health

The danger to health in the use of these waters can be measured most readily by the coliform determinations, although constituents of a chemical nature also warrant consideration. As in the Lake Huron - Lake Erie section, the major uses of these waters include domestic water supply, bathing, and recreation, all of which are closely related to public health.

Limits of pollution beyond which a health menace exists are discussed in chapter X of the Lake Huron - Lake Erie section.

The principal public health significance of the pollution of these waters lies in the effects produced on public and vessel water supplies. While recognized measures of treatment such as chlorination offer protection against bacterial pollution, the proximity of pollution to the intake on the Canadian side and the possibility of vessels discharging sewage almost over the mouth of the intake on the United States side clearly emphasize the need for pollution control to protect public health. Chlorination has been effective thus far in controlling water-borne diseases in these two municipal supplies. The threat to these supplies is ever present as long as pollution from human origin in varying intensities exists. This danger is more intense in the upper reaches of the lower river where the M.P.N. values on the average exceed acceptable limits. In addition, phenols are sufficiently high to interfere with the development of public water supplies. They persist in such concentrations for a distance of 25 miles below the locks.

The extent of pollution in the navigation channels of this section of the boundary precludes the use of the waters on vessels without treatment.

In the upper river, except for localized areas, the water is of acceptable quality for bathing purposes. In much of the lower river the pollution is sufficiently high to create a health hazard to bathers.

Injury to Property

Injury to property is evidenced by deposition of solids of waste origin on water front property, interference with the development of bathing beaches, additional cost of water treatment at Sault Ste. Marie, Ontario, and fouling of shore areas by oil.

SOURCES OF POLLUTION

Pollution in this section results from municipal sewage and industrial wastes containing solids, phenols, cyanides, ammonium compounds and oils.

The St. Marys River receives 6,620,000 U. S. (5,510,000 Imp.) gallons of untreated domestic sewage per day from a contributing population of some 46,000. Nearly all of this enters the river below the locks.

Industrial waste reaching the river amounts to 148,000,000 U.S. (124,000,000 Imp.) gallons per day of which 2,000,000 gallons originate on the United States side. About 22,000,000 Imperial gallons of this is cooling water. The daily discharge of the more significant of these wastes was found to be 280 pounds of phenols, 3,170 pounds of cyanides, 48,000 pounds of ammonium compounds, 850 Imperial gallons of oil, 79,800 pounds of suspended solids, and organic matter having a biochemical oxygen demand of 225,700 pounds.

At the height of the navigation season in 1947 the domestic sewage discharged from vessels navigating the St. Marys River was equivalent to that from a daily population of 1,000 persons, and amounted to an estimated 30,000 U.S. (25,000 Imp.) gallons per day. For the same period the estimated amount of garbage averaged 500 pounds per day. These quantities do not take into consideration the conditions which occur when a number of vessels are anchored above the locks due to bad weather which may delay their departure for days at a time.

Garbage and refuse disposal by the bordering municipalities of Sault Ste.Marie does not bear any significance to the pollution of these waters. On the United States side, the municipal dumping grounds are not located in proximity to boundary waters. On the Canadian side, garbage and refuse from the municipality is disposed of by incineration.

REMEDIAL MEASURES

It has been shown that pollution in these waters has an injurious effect on drinking water supplies, bathing, and recreation. The nature, extent, and sources of the pollution have been discussed. Pollution crosses from each side of the boundary to the other. Measures for remedying this situation is the only remaining question in the reference.

Objectives for Boundary Waters Quality Control

Remedial measures involve the treatment or control of all sources of pollution reaching the boundary waters. The "Objectives for Boundary Waters Quality Control," formulated for the Lake Huron - Lake Erie section are also applicable to the Lake Superior - Lake Huron section. They are discussed and presented in chapter X.

Hearings Before the Commission

Public hearings for municipalities, industries, and all other interested parties were held by the Commission at Sault Ste. Marie, Ontario at the conclusion of the field studies. The purpose of these hearings was to obtain information on waste treatment processes now in use or proposed, cost estimates of remedial measures, time required to carry out these measures, and comments on the application of the objectives to specific wastes. The principal points developed at the hearings were as follows;

(a) The pollution of boundary waters between the United States and Canada reached such a degree of contamination as to stimulate complaints.

(b) The evidence brought out at the hearings indicates that the pollution affecting municipal water supplies is due both to industrial wastes and domestic sewage.

(c) Plans of industries for dealing with their waste problems indicate that most of the industries take their responsibilities for keeping deleterious wastes out of boundary waters seriously, and are making plans for treatment of their wastes.

(d) Plans for collecting and treating municipal wastes are completed by one municipality and in preparation by the other.

(e) The municipalities are inactive at the present time as far as the construction of works for treating their waste is concerned. Boundary waters are denied the benefits of municipal pollution control by the limited ability of communities to finance treatment works.

(f) The need for promptly providing funds to construct necessary municipal treatment works has been shown.

(g) The people living near the boundary waters have been denied the recreational use of certain areas of these waters because of pollution.

(h) To encourage recreational development and to assure future industries a supply of reasonably clean water for industrial purposes, it is necessary to curb the tendency toward increased pollution and to eliminate much of the waste now being added to these waters.

(i) Evidence has been presented that the International Joint Commission should maintain a continuing interest in the condition of these boundary waters, and that an effective way should be found in which to exercise such interest.

Pollution Control Program

The pollution problem must be considered in terms of the future as well as on the basis of present day needs. Municipal sewage treatment facilities should be planned to incorporate flexibility for expansion and to satisfy future demands. Treatment of industrial wastes must be not only adequate for the present, but the programs must ensure that new wastes or increase in wastes will not jeopardize the rights of users of these waters. Industry must continue to bear its responsibility for satisfactory disposal of its own wastes.

Disposal of Municipal Wastes

The immediate problem in the disposal of municipal wastes is centered in the Sault Ste. Marie area. The daily discharge of about 6,000,000 gallons of raw sewage imposes a heavy bacterial load on the river. This is evidenced in the lower river and down through the Lake George Channel.

It is the opinion of the Advisory Board that work should be initiated without delay on the construction of disposal works for primary treatment and disinfection of all domestic sewage from both cities. Provision should be made for secondary treatment as new factors affecting the problem are introduced. As the stream sanitation program progresses the need for additional control of pollution from combined sewer overflows will develop.

Disposal of Industrial Wastes

The volume of industrial wastes discharged directly into these waters is 148 million U.S. (123 million Imp.) gallons per day. This is nearly 25 times the volume of domestic sewage. Separation of these wastes in the industry may reduce the volume to be treated. Each waste must be considered individually in relation to the pollutants carried. All effluents should meet the objectives for boundary waters quality control, whether discharged through municipal outfalls or directly to the stream. This requires proper consideration for the prevention of slugs and spills.

Disposal of Other Wastes

Other wastes in this section come chiefly from navigation. Vessels contribute bacterial pollution through the discharge of sewage. This objectionable practice can be corrected by the use of sewage retention tanks, accompanied by some form of treatment or sterilization of the contents. This requirement should apply to commercial vessels equipped with flush toilets and to craft used for living purposes.

PROGRESS IN POLLUTION CONTROL

No construction has yet been undertaken in the programs for treatment of the sewage from the two cities. Construction plans for interceptors and a primary treatment plant have been completed for Sault Ste. Marie, Michigan. An engineering report has been prepared for interceptors and a primary treatment plant for Sault Ste. Marie, Ontario.

The status of industrial waste treatment programs on each side of the boundary is as follows:

For Michigan:

Industry	Present Status
Northwestern Leather Company	
Sewage	Plans under way.
Industrial Waste	Plans completed.
Union Carbide and Carbon Company	
Sewage	Plans under way.
Industrial Waste	Control measures provided.

For Ontario:

Abitibi Power and Paper Company	
Sewage	Plans under way.
Industrial Waste	Studies under way.
Algoma Steel Corporation	
Sewage	Plans under way.
Industrial Waste	Studies under way but no construction of treatment works undertaken.

Dominion Tar and Chemical Company		
	Sewage	Plans under way.
	Industrial Waste	Alterations being made to eliminate the effects of spills.

COSTS AND FINANCING

The following estimates have been prepared on costs for remedial measures. The municipal costs are for interceptors and primary treatment. Costs for industries are estimated on the basis of compliance with the objectives for boundary waters quality control.

Costs for Municipalities:		
United States side	-	$1,250,000
Canadian side	-	2,750,000
Total municipal		$4,000,000
Costs for Industries:		
United States side		$ 150,000
Canadian side		350,000
Total industrial		$ 500,000
GRAND TOTAL		$4,500,000

Financial difficulties have created a strong deterrent against progress in water pollution programs. Remedial works for treating municipal sewage must be constructed through public funds. The problem in this respect is similar to that in the Lake Huron - Lake Erie section. Both cities have indicated difficulties in financing these necessary measures.

THE CONTINUING PROGRAM

The pollution program is an ever changing one. The fulfillment of the objectives will need time and continuous supervision. It is believed that progress will be aided if a technical committee or board be established to maintain a continuing interest in the pollution problem. Such a committee would supplement and strengthen the efforts made by local authorities and would permit the interchange of reports on progress. This would be advantageous here as it would be for other sections of the boundary waters.

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